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(Preparing for entrance to engineering colleges.)

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English
German
United States History
Mechanical Drawing
Chemistry
Physics

ELECTRICAL ENGINEERING

Electrical Engineering
Central Station Work
Electric Lighting
Electric Railways
Telephone Practice
Alternating Current Work
The Electric Telegraph

MECHANICAL ENGINEERING

Mechanical Engineering
Mechanical Electrical Engineering
Shop Practice
Sheet Metal Pattern Drafting
Boiler Makers' Course
Tool Makers' Course
Sheet Metal Course
Metal Roofing
Cornice Work
Tinsmithing

STEAM ENGINEERING

Stationary Engineering
Marine Engineering
Locomotive Engineering
Boilers and Engines
Special Marine
Special Locomotive Firemen's Course (Preparation for License Examinations)
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"GREATLY BEGIN! THOUGH THOU HAVE TIME
"BUT FOR A LINE, BE THAT SUBLIME.
"NOT FAILURE, BUT LOW AIM IS CRIME."

Lowell.

"WE ALL OF US COMPLAIN OF THE SHORTNESS OF TIME AND YET HAVE MUCH MORE THAN WE KNOW WHAT TO DO WITH. OUR LIVES ARE SPENT IN DOING NOTHING AT ALL, OR IN DOING NOTHING THAT WE OUGHT TO DO; WE ARE ALWAYS COMPLAINING OUR DAYS ARE FEW, AND ACTING AS THOUGH THERE WOULD BE NO END OF THEM."

Seneca.

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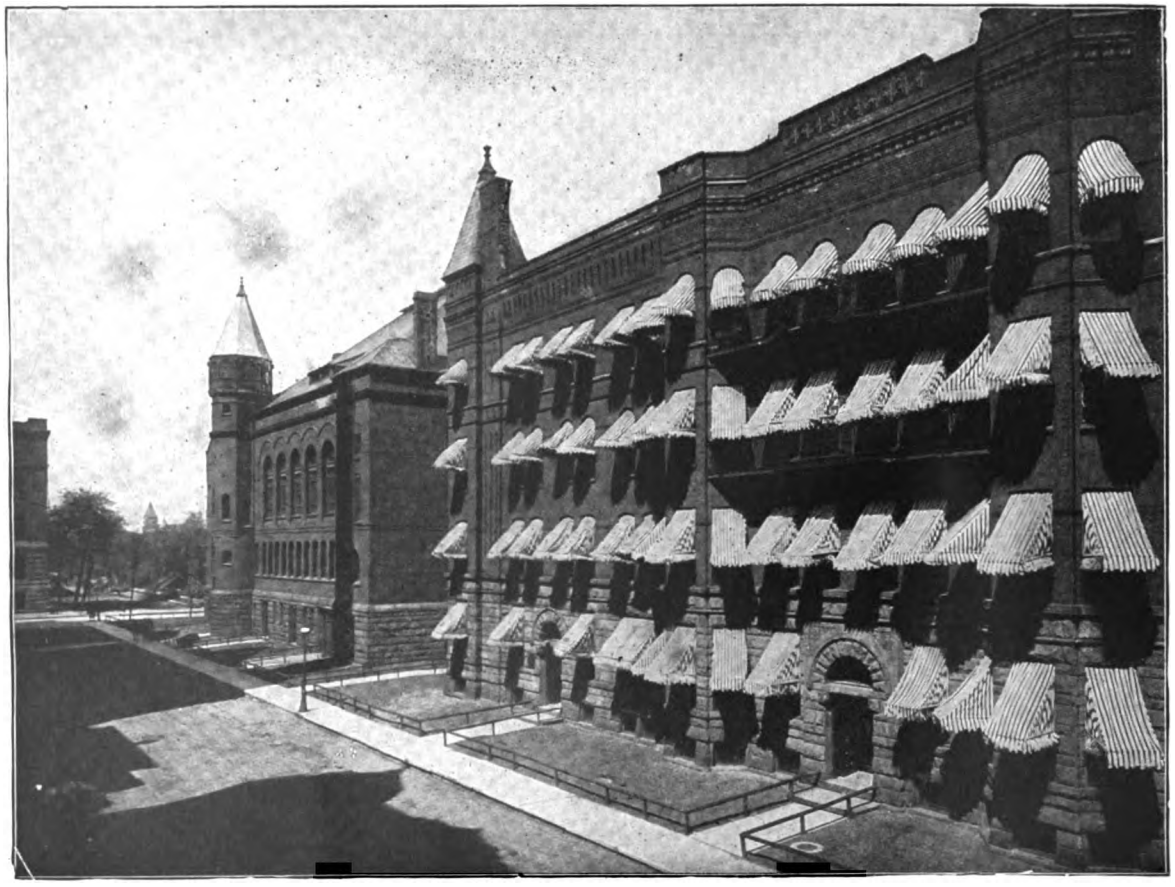

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of the

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Published quarterly for students, graduates, and others interested in the School and its work.

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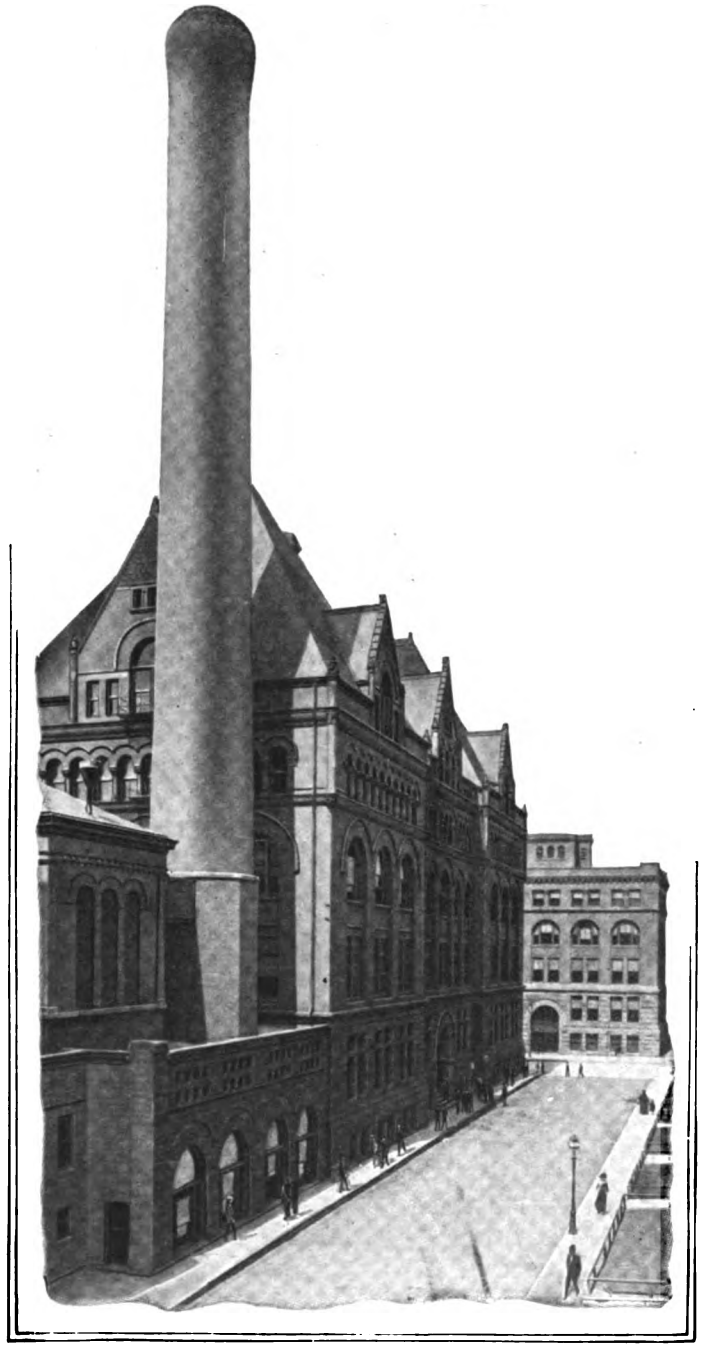

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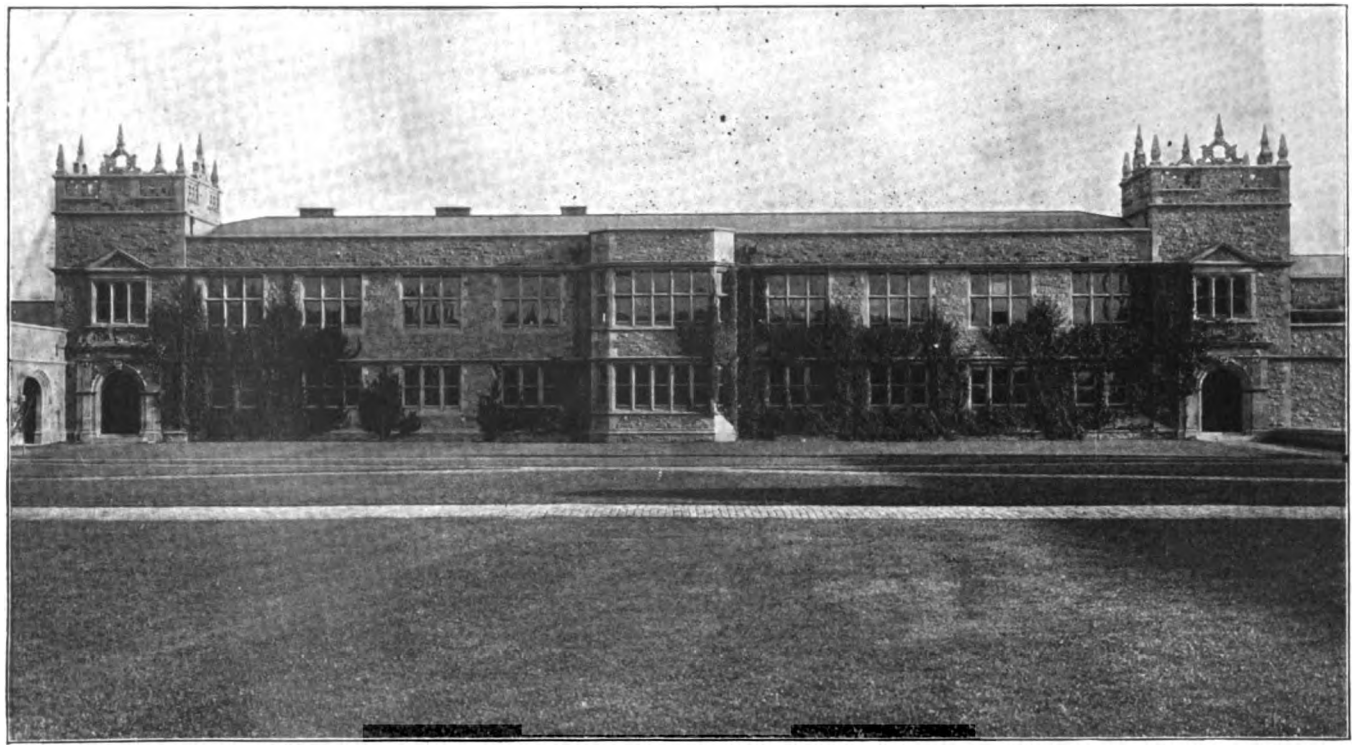

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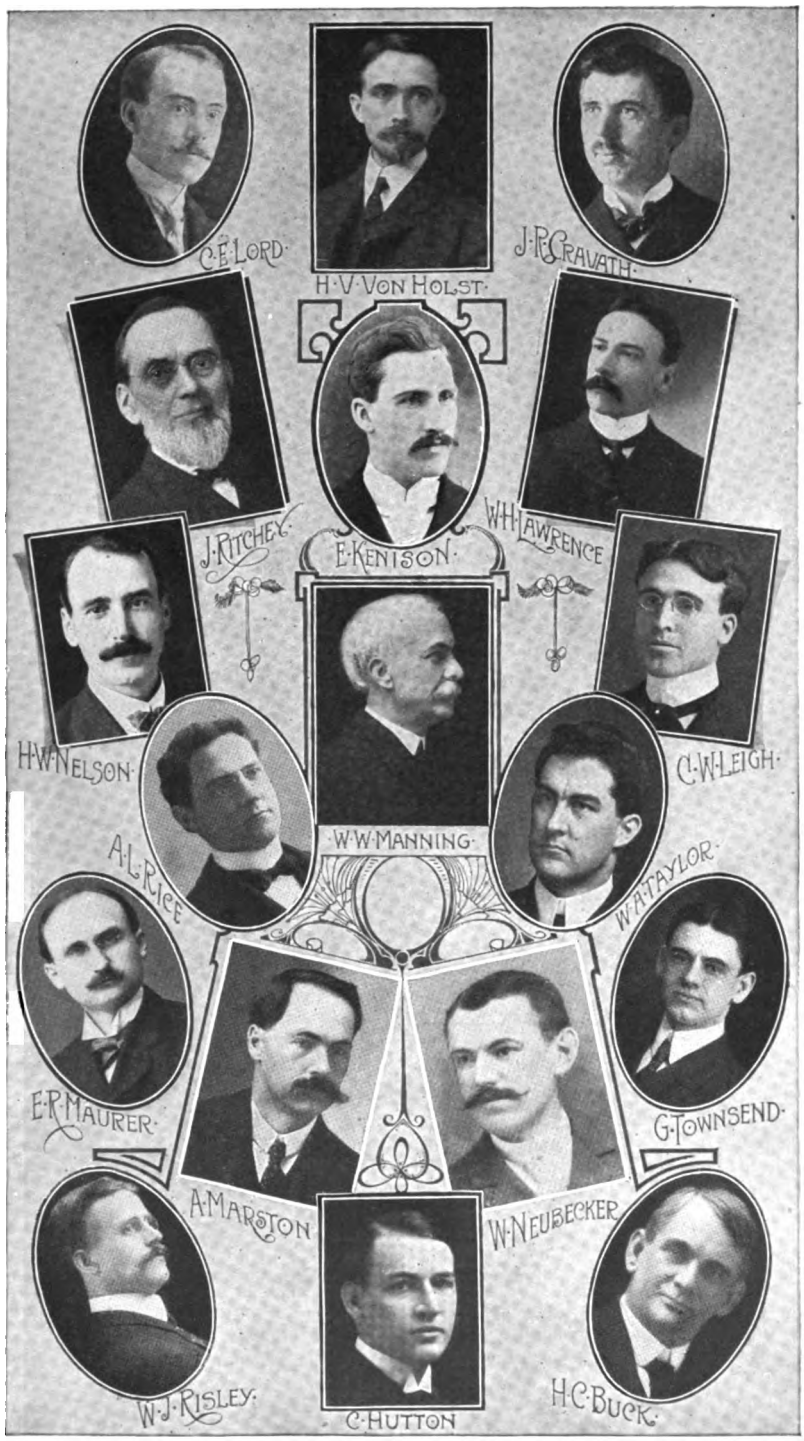

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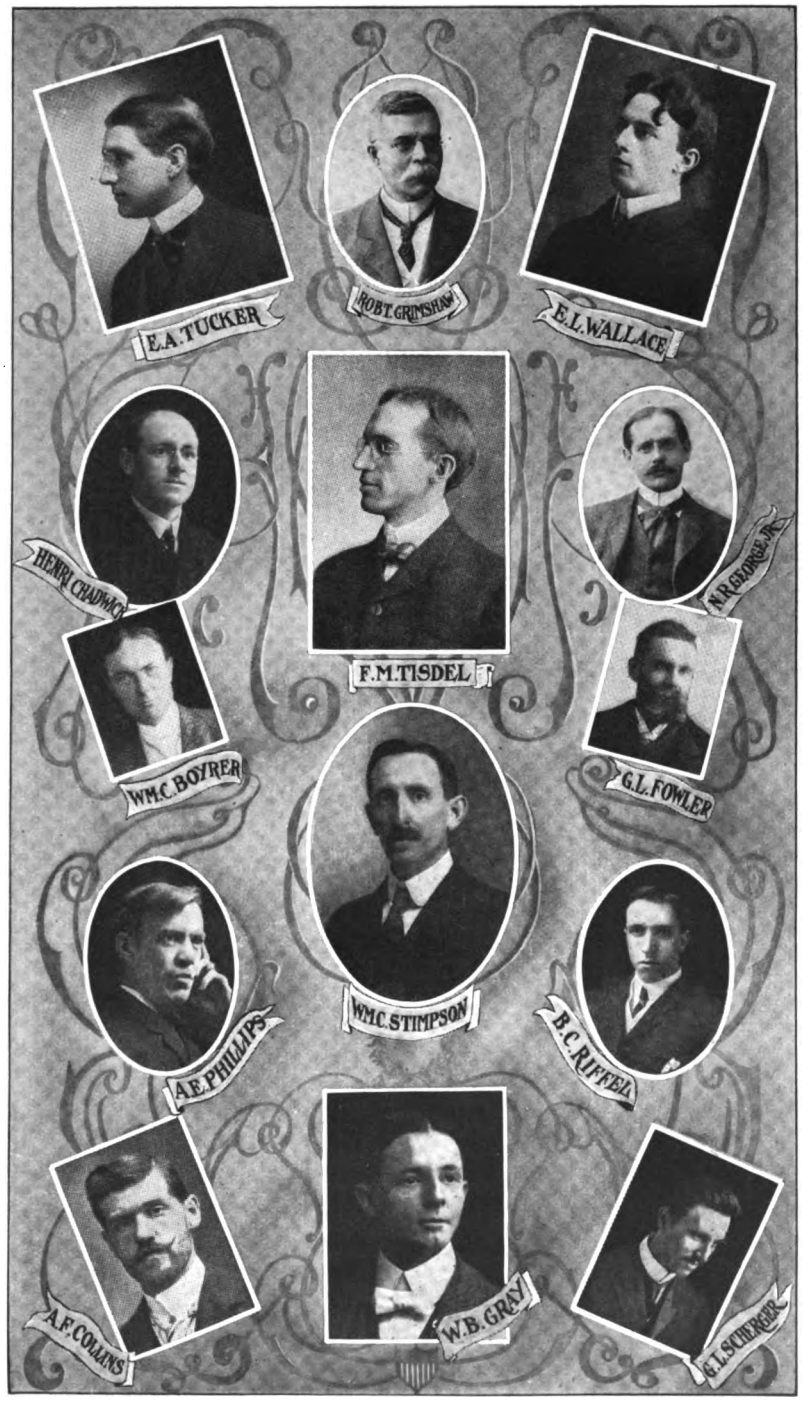

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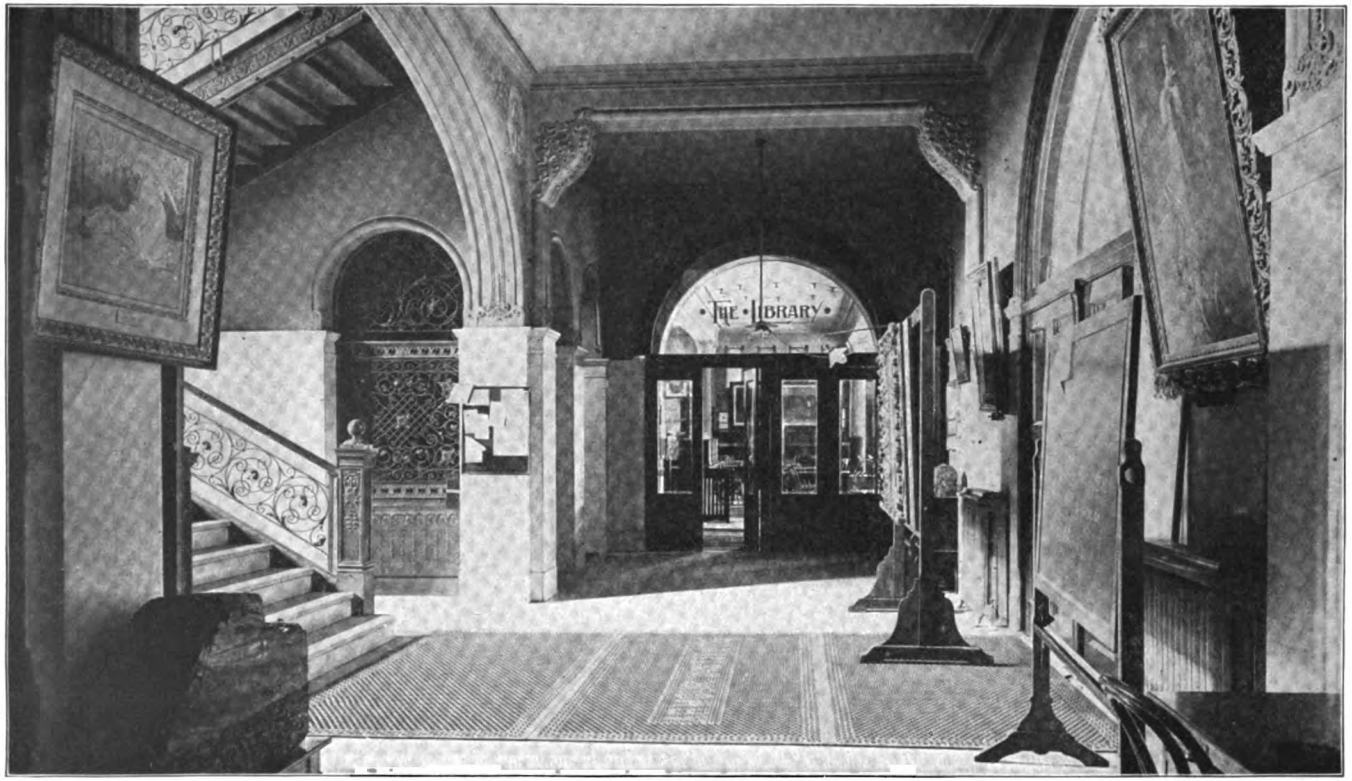

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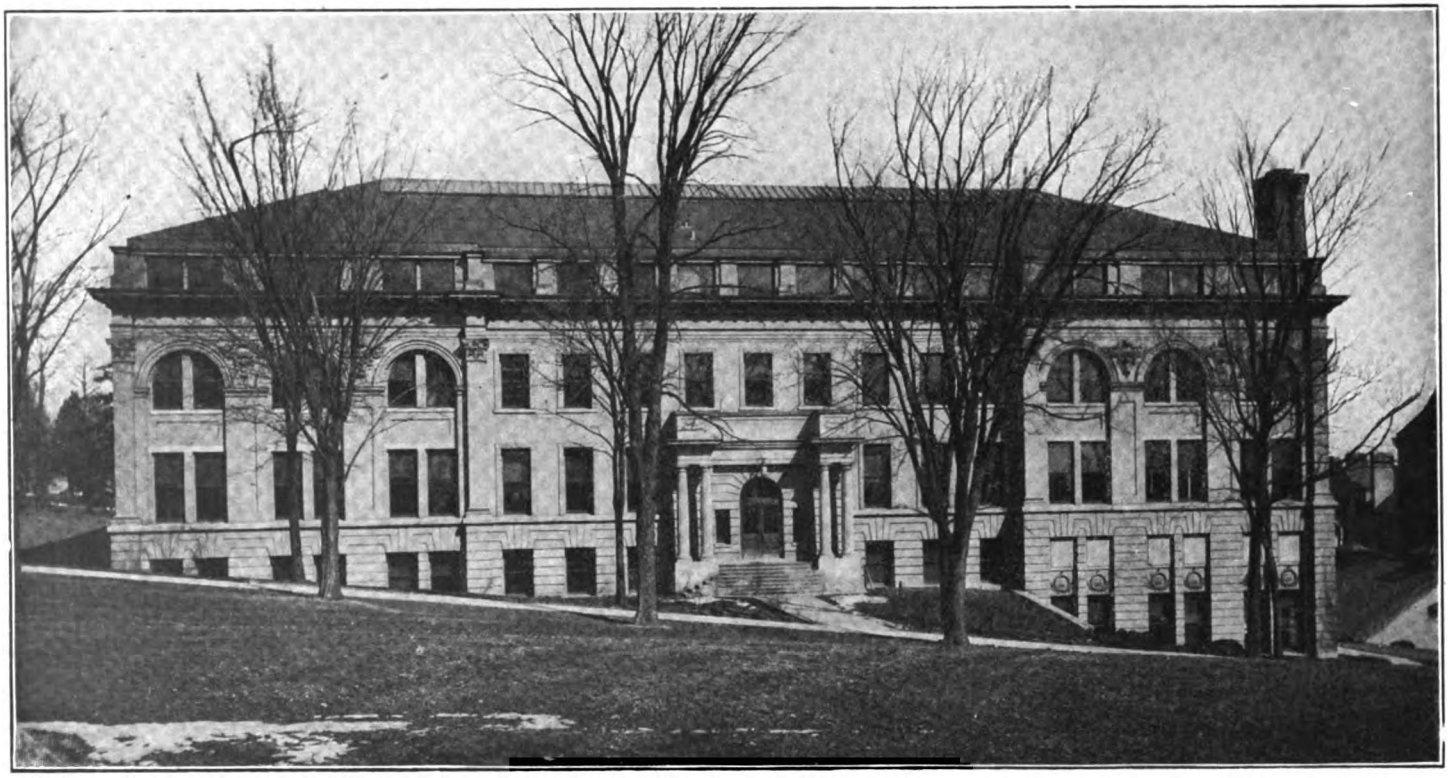

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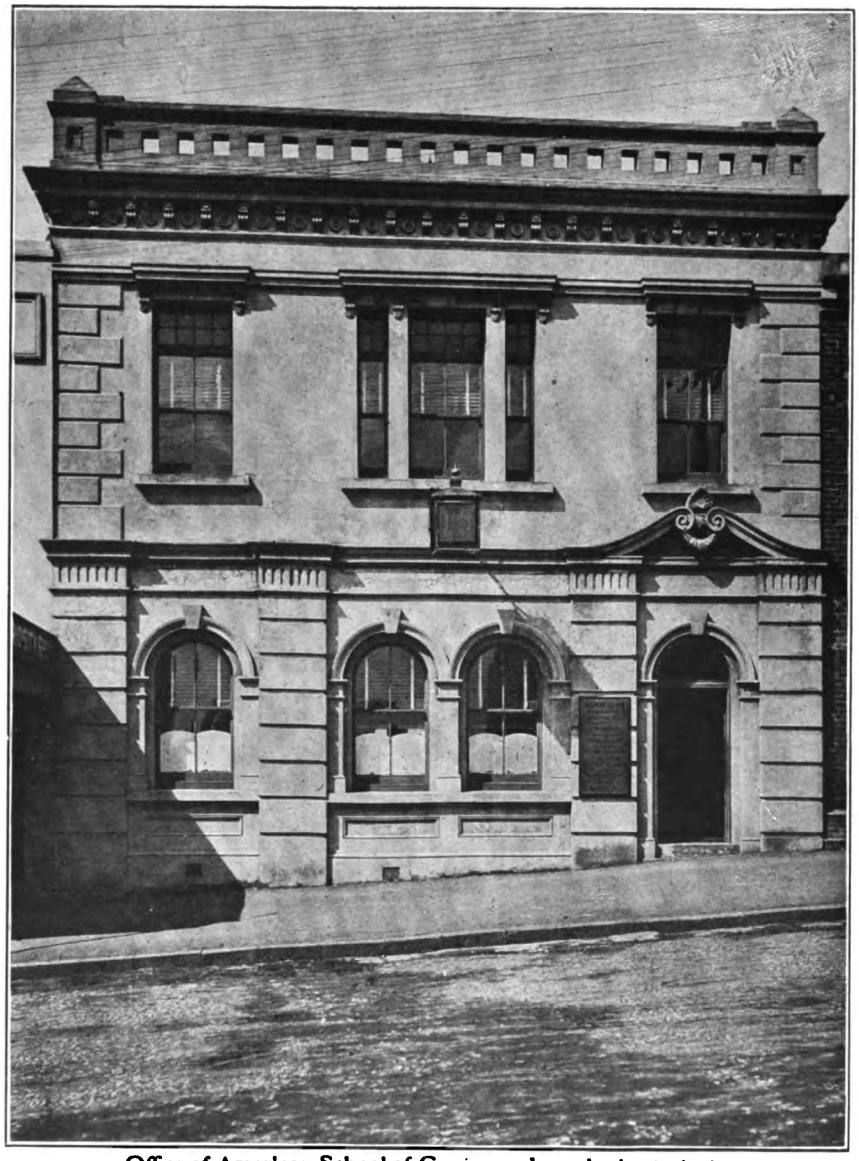

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CORRESPONDENCE teaching is the most effective means of extending the benefits of our great colleges and technical schools to that large class of aspiring persons who are beyond the range of regular college influence, who yet have a few leisure hours which they would gladly devote to home study under the direction of resident school instructors. Many of these people are too old to go to a regular school; some are too busy; and a larger number have not the means. The busy class will find that an hour here and there devoted to study, will do much to keep them abreast of the times and extend their knowledge. Those people who are unable to afford a course at a resident school constitute a vast army of intelligent, ambitious young men to whom a thorough training in some particular branch of industry would mean sure and rapid advancement. It would mean even more than that—namely, self-respect, mastery and a finer, stronger manhood. It was to extend to these classes some of the benefits of our great colleges and technical schools that the American School of Correspondence was founded.

For Whom Intended

It also offers parents who have not the means to send their children to a college of engineering an opportunity to obtain for them a certain amount of mental and technical training at a moderate cost under the supervision of men of acknowledged standing and experience. Students of engineering schools who, for any reason, are compelled to drop their class work temporarily are also offered an opportunity to go on with their studies until they can return to their classes.

A Common-Sense View

Intelligent people to-day believe in the common-sense plan of spending a portion of their spare time in self-improvement. If a man does not study he remains stationary or in a rut, and gradually grows to be a mere machine, to be soon thrown aside for a new and up-to-date type.

Successful correspondence teaching is that which places the student under the same instructors and methods which have proved most effective in our great resident schools. Where this is done correspondence work is brought into accord with resident college

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teaching, and should and does receive proper credit when residence work is desired. The University of Chicago and several other institutions in the United States maintain correspondence departments and credit non-resident work toward a degree. The American School of Correspondence is the first in this country to provide correspondence instruction for wage-earners in engineering practice which counts toward entrance upon higher resident instruction. *American School students are taught under the supervision of the men who preside over the laboratories and teach the classes of the Armour Institute of Technology and other technical schools.* Thus through our instructors, the extensive shops, laboratories and libraries of a great technical school offer their results and guidance to ambitious students in every part of the world.

Correspondence Work Accepted Toward Resident Work

Teaching by correspondence is a method of imparting knowledge by means of written instead of oral instruction, and is especially adapted to persons whose time for study is necessarily limited and irregular. It has some evident advantages over the oral method where pupils are too often crowded together in a classroom and all forced to make the same progress, regardless of individual ability or aptitude. The correspondence student is free to select whatever course of study is best adapted to his particular needs; he is in a class by himself, and is not compelled to suit his hours for study to those of other students. If he is especially apt or has already covered part of the work, he is not held back by certain members of a class who are slower. On the other hand, if he has not had the advantages of much preliminary education he will not become discouraged in vainly trying to keep up with a class whose members have had better training than he.

Student in Class by Himself

The correspondence student's needs are studied from the point of view of the factory, the workshop, or the railroad, and practical courses especially adapted to these needs are prepared for him by men of broad training. Every course begins with simple arithmetic, and progresses step by step, to more advanced subjects. The "reason why" is always carefully explained, and the student is thoroughly grounded in the fundamental principles. The correspondence student naturally becomes self-reliant and develops into the type of man who *knows*, and *knows* that he *knows*—and can prove it, for he has learned it himself, taking time to thoroughly master every point. He usually has his laboratory in

Lessons Suited to Needs of Students

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his workshop and there tests his knowledge as it comes to him from the instruction papers. After years of experience, the true founder of correspondence work in America, President Harper, goes so far as to say: "Direction and correction may be given oftentimes more effectively by written than by spoken word." It is at least safe to say that, so long as correspondence instruction under the supervision of successful teachers is offered, even the man who cannot go to school need not despair of receiving valuable education.

Personal Attention

Surprising as it may seem, the correspondence student oftentimes receives more personal attention than is usually accorded to the classroom student, and he makes rapid progress indeed in proportion to the number of hours spent in study. He does not use the ordinary college textbooks, which are often too difficult and technical for him, but each one of his lessons shows that it has been carefully written by a teacher who has kept his special need in mind and has found out how to remove any possibility of difficulty, thus making every point absolutely clear. This he does by regular printed blackboard work, by drawings, and by little extra side-talks showing how principles may be applied to practical work. Thus each lesson is a text-book, a lecture and a blackboard exercise combined, with all difficult matter carefully omitted or made clear.

Furthermore the lessons provide for a thorough examination at frequent intervals, which keeps the student in constant touch with his teachers, and continually furnishes him with new and better methods of doing his work. If any difficulty arises, the Inquiry Department supplies the desired assistance.

Lack of Education No Hindrance

Experience has shown that correspondence students are particularly diligent and earnest in their work. This is so because they are as a class, more mature and have learned by experience to take a more serious view of life's struggle. If some of them have had practically no education to begin with, they need not be discouraged, for in any case they always start at the very bottom, with the most elementary principles. Any man who has perseverance and a thirst for knowledge can overcome the lack of early education.

It is confidently believed that the American School of Correspondence meets a long-felt need on the part of ambitious mechanics, clerks, apprentices, teachers, farmers, students and business men for an opportunity of studying at home some branch of applied science under the guidance of teachers of resident schools of recognized standing.

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Fac-Simile of Gold Medal Diploma awarded by the St. Louis Exposition for Methods of Instruction in Engineering and for Technical Publications

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Fac-simile of Gold Medal Diploma awarded by the Portland Exposition, for Excellence of Correspondence Instruction

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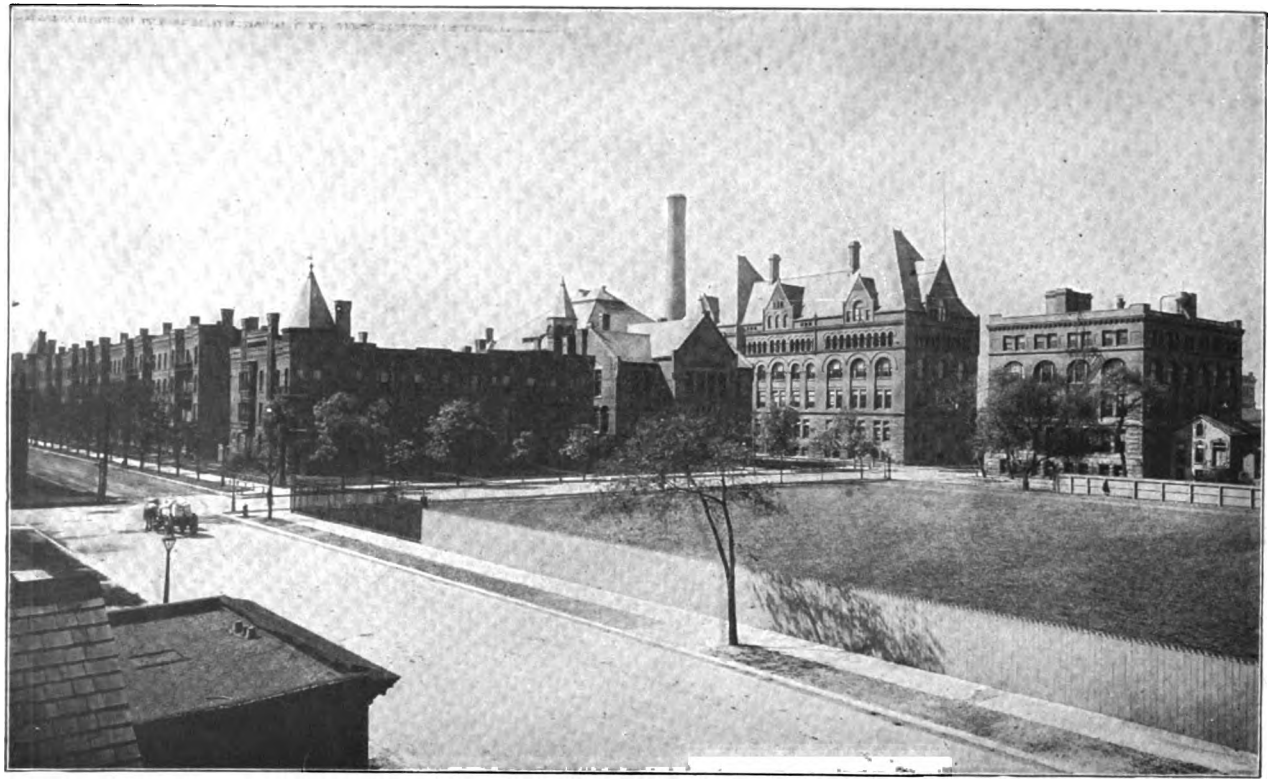

Armour Institute of Technology, looking across Ogden Field

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GENERAL INFORMATION

Purpose of the School. The American School of Correspondence aims to bring a technical education within the reach of the great wage-earning classes and those who, through lack of time or means, are unable to avail themselves of the advantages of a resident school.

Location. Chicago, a great educational and industrial center, is an ideal location for a correspondence school. No city in the United States has better mailing facilities for correspondence work. The number and variety of manufacturing establishments in and about Chicago make it possible for the Employment Department to assist distant students, who wish to attend the evening classes of the various technical schools, in securing positions in this city. Furthermore, Chicago's extensive libraries, well equipped shops and laboratories make it possible for the School to obtain for its students the latest and best information pertaining to any field of engineering.

Requirements for Admission. No entrance examination is required, nor is there any age limit. Applicants, however, must be able to read and write English and should be able to devote at least three hours per week to their studies.

How Correspondence Work is Conducted. Upon enrolling, the student is furnished his first Instruction Papers, together with full instruction as to how to begin work. The First Instruction Paper is taken up and read very carefully until each point is thoroughly mastered. The student then sends in an examination on that book to the school. This examination is carefully corrected, criticised, and graded by the instructor. Corrections are made as to errors in facts, figures, punctuation, capitalization and grammar. Explanations and suggestions are made by the instructor. The student, in the meantime, is working on his next lesson paper.

Inquiry Blanks. Should the student meet with difficulty in his studies, he is expected to fill out an Inquiry Blank, furnished him by the School, which he mails to the Instruction Department, receiving in reply a complete "Blackboard" explanation.

Blackboard Method. Our "Blackboard" method is a very important feature of our work. It gives the student who does not

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thoroughly understand a problem, a complete demonstration, showing how and why each step is taken in the solution of a problem. It is somewhat similar to the blackboard work in the college class-room, but has this advantage: the instructor's demonstration may be kept and referred to at any time, whereas the blackboard work in the class-room is soon erased.

Instruction Papers. The Instruction Papers have been prepared especially for correspondence work by engineers and teachers who, through long practical experience and training, are in a position to know the needs of correspondence students. The papers are frequently revised to keep them up-to-date in the best and latest engineering practice. Each subject is taken up from the beginning and thorough explanations are given in a clear, concise manner as the student progresses. They average about eighty pages each, substantially bound in cloth, and form a valuable reference work for the student after the completion of his course.

Office of the President
American School of Correspondence

Special Examinations. Mathematics is the basis of all mechanical study; hence Arithmetic is given first to all students. If, however, a student already proficient in Mathematics does not care to take up the preliminary work in Arithmetic, he will be given, upon application, a special examination. This concession does not apply to other subjects, as a rule, and diplomas are awarded only to those who have carefully covered all of the course, except Arithmetic. All students, however, are strongly advised to work out all the examinations in Arithmetic.

System of Marking. In marking the student's work, the School has adopted the system used in many leading colleges, grading each paper "Perfect," "Excellent," "Good," or "Fair." These grades correspond to the following percentages: "Perfect," 100%; "Excellent," 90 to 100%; "Good," 80 to 90%; "Fair," 75 to 80%. The percentages obtained by the student in each subject are kept at the School, and the student's average per cent is given to him upon graduation.

Final Examination. As a rule, the student is required to take a final examination before being awarded a Diploma or Certificate of

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Pierce Hall, Harvard University

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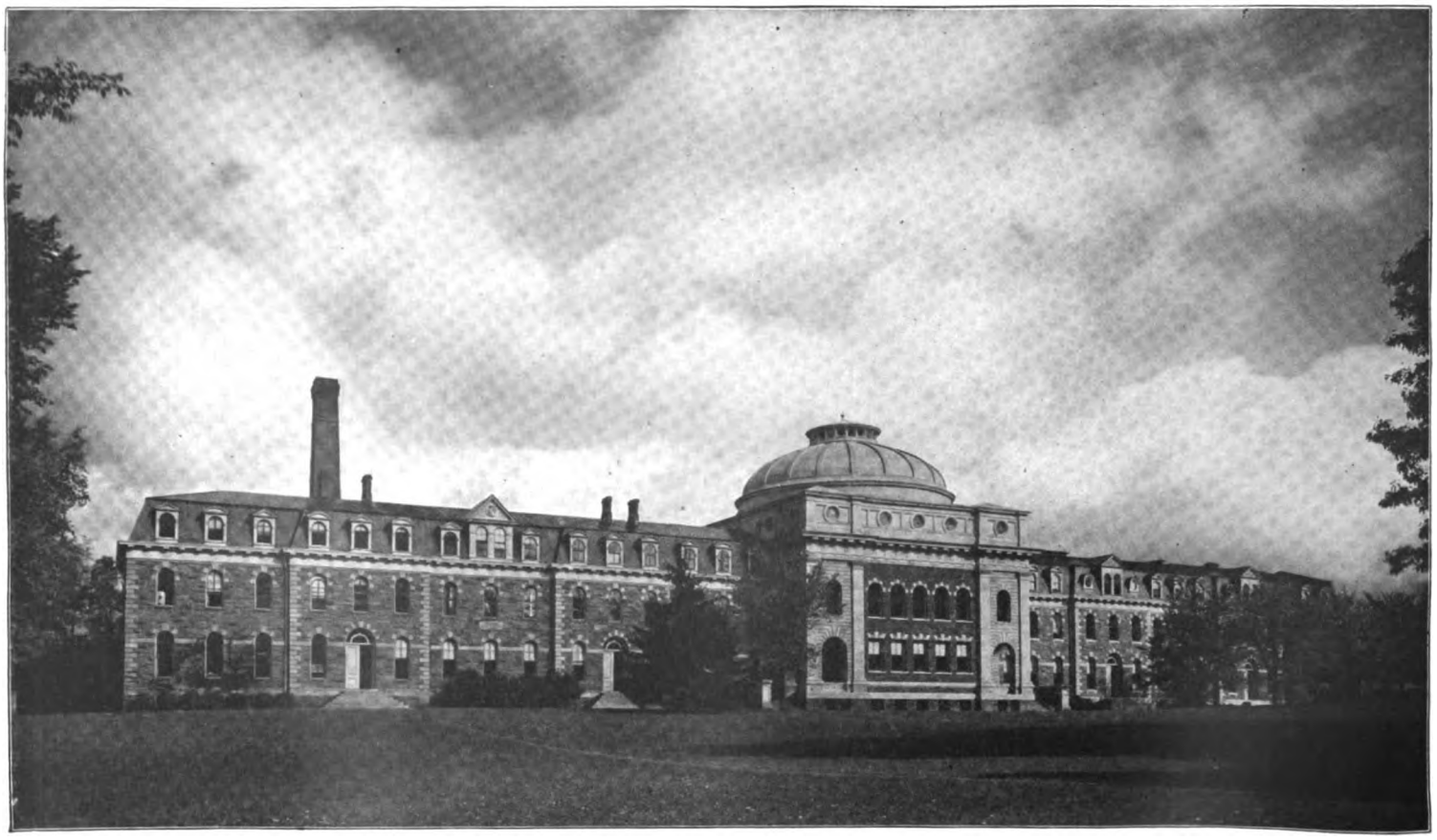

SIBLEY COLLEGE OF MECHANICAL ENGINEERING, CORNELL UNIVERSITY, ITHACA, N. Y.

Immediately back of this building is the beautiful Fall Creek gorge, furnishing water power for hydraulic experiments.

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Proficiency. If his work, however, has been of high character throughout his course, no final examination is required.

Diplomas and Certificates of Proficiency. After having completed his course, and having satisfactorily passed all the examinations, the student is awarded a Diploma, certifying to these facts. This Diploma constitutes a guarantee of proficiency which has come to be recognized by our great manufacturers and other employers of technically trained men as the best possible recommendation.

Employment Department. This department aids students and graduates in securing positions for which their training has fitted them. It also co-operates with employers, furnishing reliable, well-trained men. The School frequently receives requests from manufacturers and engineering firms in all parts of the country for well-trained men from among its students and graduates, and the number of these requests exceeds the School's list of available graduates and advanced students. The School keeps in touch with manufacturing interests everywhere, and is thus able to lay out courses adapted to the student's needs. Graduates and advanced students have almost invariably obtained good positions and in the section of the country desired. The School will always, upon request, advise any employer of the progress and educational capabilities of a student, or render any service to its students within its power.

Office of the Secretary
American School of Correspondence

Special Inquiry Department. This department is one of the sources from which a student can derive the greatest benefit. It offers a student the privilege of submitting to the Instruction Staff practical engineering questions connected with his daily work. Questions are answered in a simple, concise and practical manner and the explanation is accompanied by diagrams when necessary. Thus the School co-operates with the ambitious student in making his daily work most valuable to his employer and to himself.

Library Department. To facilitate the student's progress and to afford him a larger opportunity for reading, study and reference in subjects allied to his own course, the School has compiled a reference library in twelve volumes, entitled "Modern Engineering Practice." This Library is a comprehensive reference work on prac-

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Corner of Instruction Department

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tical methods for the Machine Shop, Engine Room, Power House, Electrical Light Station, Boiler Shop, Drafting Room, Foundry, Pattern Room, Blacksmith Shop, Round House, Plumbing Shop and Factory. For the busy mechanic, this Library is of great value, and supplies in a concise form the information needed to meet the hundred and one practical problems arising in every-day work.

Office of the Director
American School of Correspondence

Bound Instruction Papers. The Instruction Papers, of which there are about fifty in the full courses, are bound in handsome and substantial cloth, and thus make a great addition to one's library. In this respect the policy of the School differs from that of other correspondence schools, which furnish their students with Instruction Papers cheaply bound in paper.

Time Limit. A Student ordinarily completes his course in from eighteen months to two years, according to his aptitude, previous training and time for study. Obstacles, however, sometimes arise which impede a student's progress and for this reason five years' time is allowed in which to complete any course.

What a Scholarship Includes. The tuition entitles the student to instruction until his course is completed, provided this is accomplished within five years from date of enrollment. All textbooks and supplies are furnished free except drawing instruments and blank paper. The School pays postage on all letters and supplies sent by mail to the student.

College Preparatory Work. There are a great many people who would gladly attend College if four years' High School work were not required for entrance to such institutions.

It was to meet the needs of such persons that the College Preparatory work was inaugurated. Students satisfactorily completing the course as outlined on Page 162 of this Catalogue will be admitted to Armour Institute of Technology, and to similar institutions, without further examination in the studies pursued.

Patent Department. The School has made arrangements with an expert patent attorney who will advise all students regarding inventions which they wish to patent. The only expense will be the actual cost of making search, etc. Full description with sketches should be submitted.

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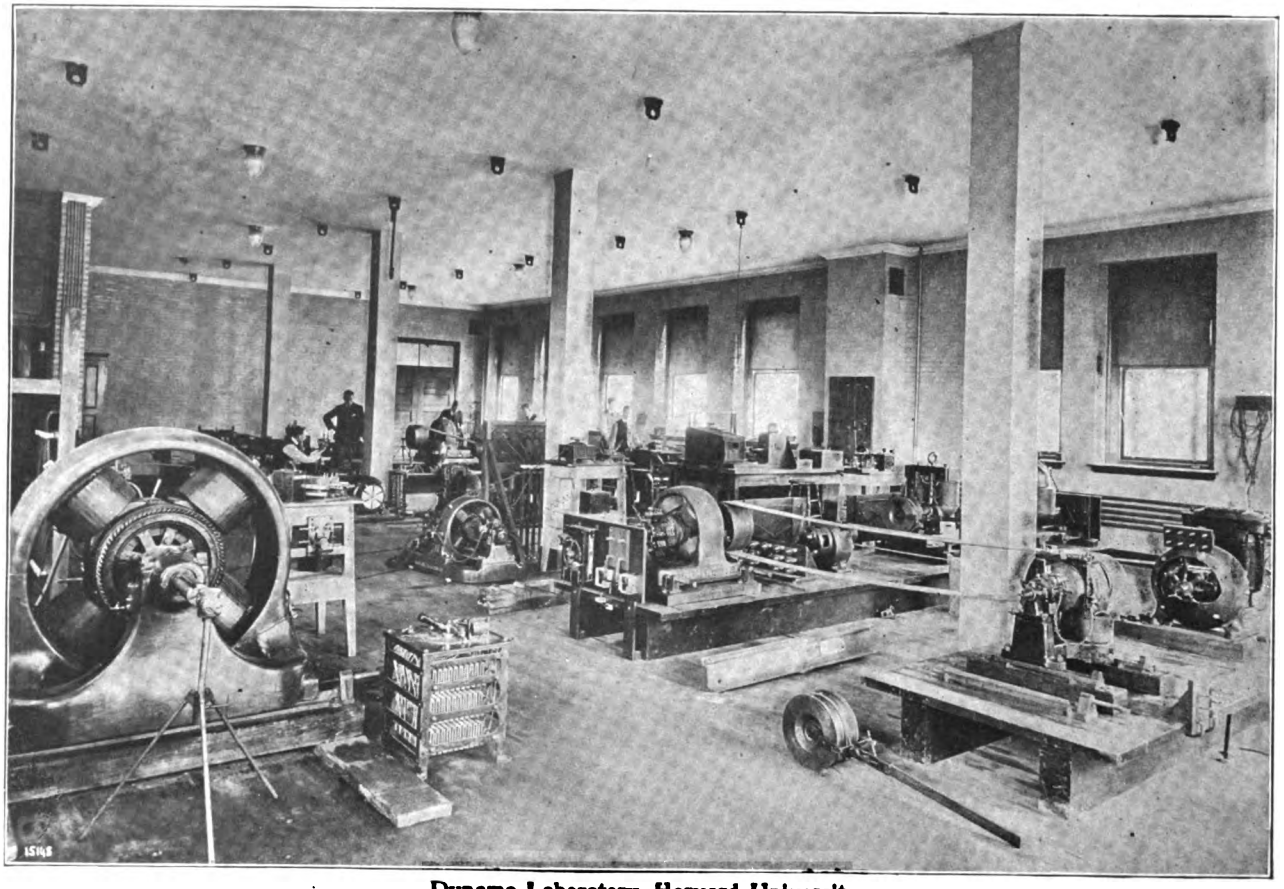

Dynamo Laboratory, Harvard University

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DEPARTMENT OF

ELECTRICAL ENGINEERING

Partial list of the well-known authorities and educators who personally have prepared the instruction papers for correspondence study.

F. B. CROCKER, E. M., Ph. D., Head of Dept. of Electrical Engineering, Columbia University.

CHARLES THOM, Western Union Telegraph Company.

H. C. CUSHING, JR., Consulting Electrical Engineer. Author "Standard Wiring for Light and Power."

WILLIAM C. BOYRER, M. E., M. M. E., formerly N. Y. and N. J. Tel. Co.

LOUIS DERR, S. B., A. M., Professor, Mass. Inst. of Technology.

WILLIAM ESTY, S. B., M. A., Head of Dept. of Electrical Engineering, Lehigh University.

LAWRENCE K. SAGER, S. B., M. P. L., Patent Attorney and Electrical Expert, formerly, U. S. Patent Office.

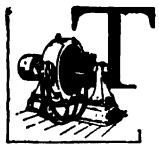
GEORGE C. SHAAD, E. E., Assistant Professor of Electrical Engineering, University of Wisconsin.

JAMES R. CRAVATH, Western Editor, "Street Railway Journal."

COURSES

ELECTRICAL ENGINEERING
MECHANICAL-ELECTRICAL ENGINEERING
CENTRAL STATION WORK
ELECTRIC LIGHTING
ELECTRIC RAILWAYS
TELEPHONE PRACTICE
THE ELECTRIC TELEGRAPH
ALTERNATING CURRENT WORK

ELECTRICAL ENGINEERING



THE rapid development of Electrical Engineering during the last few years has been due largely to a recognition of the real importance of theory. Success in practical work is attained only by the application of sound theory. The courses in this department aim to give thorough instruction concerning the most essential of these theories and their practical applications to the industrial arts.

The student first lays a foundation by taking the preliminary studies which are elementary in character and treated as briefly as the technical work will permit. The technical portion includes instruction in batteries, Ohm's law, induction, etc. Both direct and alternating current machines are discussed in detail and many suggestions given for their practical management; the application of electricity to lighting, railways, central station work, telephones and telegraph are taken up in a manner suited to the practical man as well as to the student.

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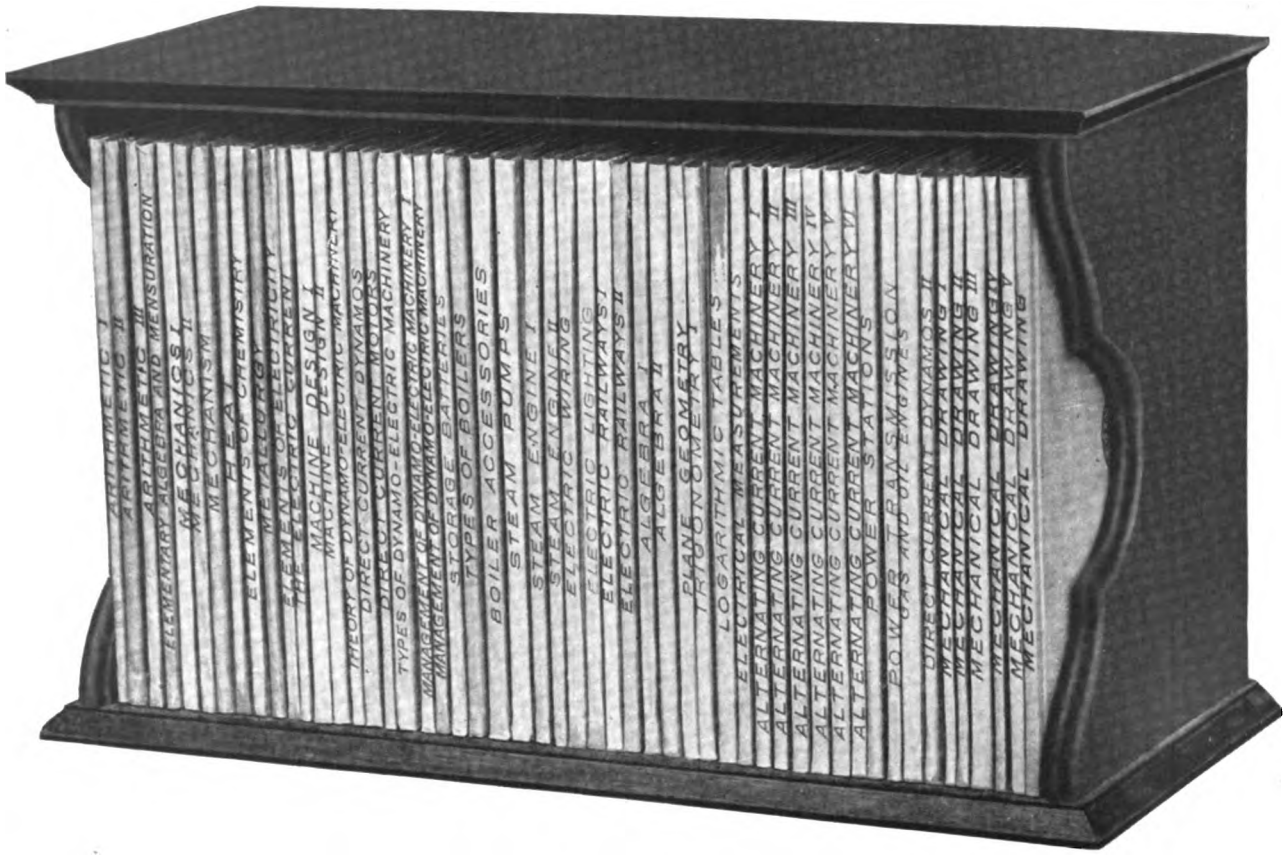

THE CLOTH BOUND INSTRUCTION BOOKS OF A FULL COURSE

Of which the above forms a fair example, constitute in themselves a practical up-to-date reference work.

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The methods of testing with instructions for using measuring instruments make the various problems easily understood. Among the interesting features of the course may be mentioned, storage-battery work, and practical directions for wiring for electric lights. To make the work more complete, especially for those engaged in central station work, instruction is given in steam boilers, pumps and engines.

ELECTRICAL ENGINEERING COURSE

Prepared for Electricians, Electrical Engineers, Power Station Engineers, Motormen, Automobile Drivers, Dynamo Tenders, Testers, Linemen, Draftsmen, Telegraph Operators, Telephone Inspectors, Lamp Trimmers, Inventors, Patent Lawyers, Instructors and Students.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Elements of Electricity.
The Electric Current.
Machine Design Part I.
Machine Design Part II.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Types of Dynamo-Electric Machinery.
Management of Dynamo-Electric Machinery Part I.
Management of Dynamo-Electric Machinery Part II.
Storage Batteries.
Types of Boilers.
Boiler Accessories.
Steam Pumps.
Steam Engine Part I.
Steam Engine Part II.
Electric Wiring.
Electric Lighting.
Electric Railways Part I.
Electric Railways Part II.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Electrical Measurements.
Alternating Current Machinery Part I.
Alternating Current Machinery Part II.
Alternating Current Machinery Part III.
Alternating Current Machinery Part IV.
Alternating Current Machinery Part V.
Alternating Current Machinery Part VI.
Power Stations.
Power Transmission.
Design of Direct Current Dynamos.
*Gas Producers.
*Gas Engines.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
*Mechanical Drawing Part V.
*Mechanical Drawing Part VI.

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*Optional.

Tuition $70.00. Payable Monthly.

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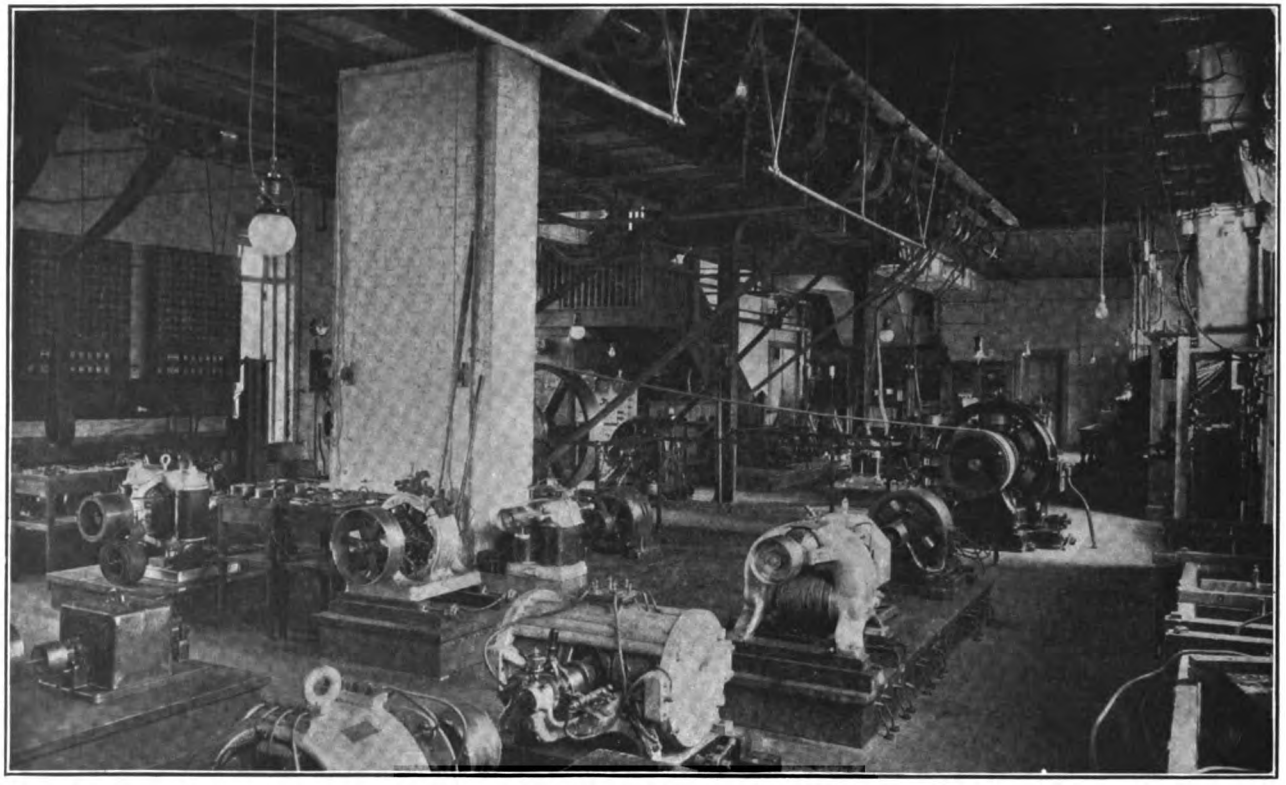

Dynamo Laboratory, University of Wisconsin

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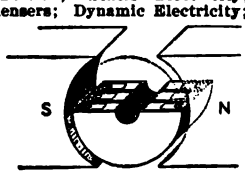
SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 166

ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.



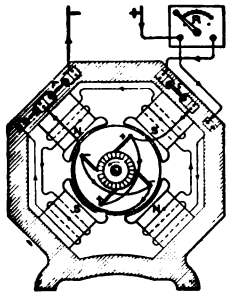
ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO-ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Fields; Series, Shunt and Compound Windings.

DIRECT CURRENT DYNAMOS: Classes; Curves; Long and Short Shunt; Field Magnets; Armature; Windings; Commutators; Brushes; Brush Holders; Field Magnets; Field Coils; Sparking; Installation; Operation; Testing. **DESIGN:** Formulas; Armature Conductor; Windings; Magnetic Density; Losses in Armature; Magnet Frame; Magnetic Flux; Air Gaps; Armature Core; Field Cores and Yoke; Pole Pieces; Armature Reactions; Efficiency.

DIRECT CURRENT MOTORS: Principles; Equations: Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Series Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

TYPES OF DYNAMO-ELECTRIC MACHINERY; DIRECT CURRENT. Classes; Methods of Driving; Types: General Electric; Crocker-Wheeler; Westinghouse; Bullock; C and C; Holtzer-Cabot, etc.; Electrolytic Work; Arc Lighting Generators; Railway Motors; Motor-Generators and Dyna-motors.



MANAGEMENT OF DYNAMO-ELECTRIC MACHINERY: Selection; Erection; Connection; Operation; Construction; Handling; Regulation; Foundations; Installation; Belts; Assembling; Wiring; Circuit Breakers; Circuits; Starting; Stopping; Generators in Parallel; Generators in Series; Three-wire System; Inspecting; Testing; Detection and Remedy of Troubles; Sparking; Heating; Noise; Railway Motors.

ELECTRIC WIRING: Circuit Breakers; Switch Board; Lightning Arresters; Motor Wiring Formulae; Tables; Outside Wiring; Poles; Inside Wiring; General Wiring Formulae; Arc-Light Wiring; Special Wiring; Moulding; Conduit Work; Fixture Wiring; Cut-outs; Sockets; Switches; Distribution of Light; Arc and Incandescent Systems; Fuses; Inspection. Fire Risks; Insurance Rules and Regulations.

STORAGE BATTERIES: Plante; Faure; Forming Plates; Setting up; Electrolyte; Tests; Discharging; Efficiency; Sulphating; Buckling; Disintegrating; Short Circuiting; Over Discharging; Uses; Connections; Diagrams; Switches; Regulation of Charging Generator; Boosters.

ELECTRIC LIGHTING: Lamps; Candle Power; Incandescent Lamps; Arc Lights; Systems of Distribution, Feeders; Potential; Location of Lamps; Power required; Location and Equipment of Plant; Overhead and Underground Systems; Wiring of Buildings; Size of Wire; Calculations.

ELECTRIC RAILWAYS: Car Equipment; Armature Coils, Loads and Brushes. Inspection; Gearing; Lubrication; Bearings; Motor Suspension; Controllers and Car Wiring; Series Parallel Control; Rheostat Control; Controller Construction and Wiring; Magnetic Blow-out; Multiple-Unit System; Car Heaters; Car Wiring; Resistances; Car Accessories; Trucks; Brakes; Air Brake; Magnetic Brake; Car Bodies; Overhead Construction; Trolley Wire; Feeders; High-Tension Lines; Third Rail; Conduit System; Track Construction; Joints; Bonding and Return Circuits; Electrolysis; Power Supply and Distribution; Alternating Current Transmission; Power Station; Switch Boards; Alternating Current Systems; Operation; Testing; Faults.

ELECTRICAL MEASUREMENTS: Units; Symbols for Physical Quantities. Galvanometers; Rheostats; Voltmeters; Ammeters; Wattmeters; Measurement of Resistance. Locating Faults; E. M. F. of Alternating Currents, Calibration of Voltmeters and Ammeters, Measurement of Energy, Quantity and Capacity.

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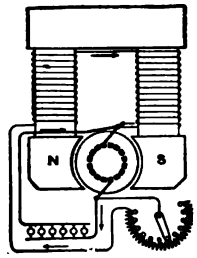
ALTERNATING-CURRENT MACHINERY: Advantages and Disadvantages of Alternating Currents; Laws; Graphic Representation; Form Factor; Instantaneous and Average Power; Harmonic E. M. F.; Inductance; Capacity; Fundamental Equation of the Alternating-Current Circuit; Resistance; Reactance; Impedance; Electric Resonance; E. M. F. Losses in Transmission Lines. Alternators; Armature Reaction; Armature Inductance; Regulation; Field Excitation; Polyphase Alternators; Measurement of Power; Armature Windings; Single-, Two- and Three-Phase Windings. Commercial Types; Revolving Armature; Revolving Field; Inductor Alternators; Losses; Efficiencies, Ratings, and Tests. Motors: Synchronous; Starting; Torque and Power Output; Field Excitation and Power Factor; The Transformer; E. M. F. and Current Relations; Regulation; Connections; Parallel and Series; Phase Transformation; The Rotary Converter; Uses; Inverted Rotary; Control of Direct-Current Voltage; Field Excitation; Testing. Induction Motor; Windings; Efficiency; Starting; Detailed comparison of Synchronous and Induction Motors; Switch-board and Station Appliances; Fuses; Feeder Regulators; Potential Regulators; The Voltmeter Compensator; Tables.



POWER STATIONS: Location of the Generating Station; Selection of System; Size. The Steam Plant; Foundations; Furnaces; Draft; Engines and Turbines. Hydraulic Plants. Gas Engines. Generators; Exciters; Transformers; Storage Batteries; Feeder panels; Safety devices. Substations; Buildings; Station Records; Methods of Charging for Power.

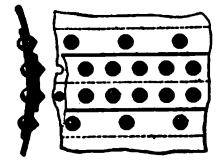
POWER TRANSMISSION: Conductors; Material; Resistance; Weight; Insulation. Distribution Systems; Series; Parallel; Series-Multiple and Multiple-series; Three-wire Systems. Regulation of Voltage; Alternating Current Distribution. Transmission Lines; Capacity; Inductance; Calculation of Alternating-Current Lines; Formulae and Application; Practical Examples of Line Calculation. Overhead Lines; Location; Supports; Poles; Insulators; Pins; Stresses sustained by the Lines; Underground Construction; Solid, Trench and Drawing-in Systems; Earthenware conduits; Cables; Selection of Voltage; Protection of Circuits.

MACHINE DESIGN

SEE SYNOPSIS PAGE 49.

STEAM BOILERS AND ENGINES

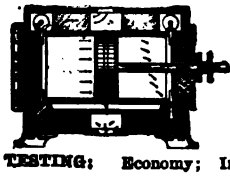
TYPES: Flue Boilers; Galloway Boilers; Fire-Tube Boilers; Vertical; Fire Engine; Water-Tube Boilers; Babcock and Wilcox; Heine; Root; Almy; Harrison; Cahall; Yarrow; Thornycroft; Etc. Marine and Locomotive Boilers.



FITTINGS AND ACCESSORIES: Furnaces; Mechanical Stokers; Fuel Economizers; Down-Draft Furnaces; Valves; Gages; Fusible Plugs; Blow Off; Traps; Pumps; Injectors; Heaters; Gain by Heating Feed Water; Calorimeters; Boiler Setting; Pipes and Pipe Covering; Supports; Boiler Horse Power; Factors of Evaporation; Corrosion and Incrustation; Deterioration; Explosions; Investigation. Fuels.

CARE AND MANAGEMENT: Fittings; Feed Water; Methods of Firing; Cleaning and Banking Fires; Inspection; Testing.

PUMPS: Principles; Kinds; Suction; Forcing; Valves; Design and Construction; Capacity; Sizes for Boiler Feed; Erection and Piping; Care; Valve Setting; Types.



STEAM ENGINES: Parts; Cylinder; Piston; Crank; Valve; Eccentric; Types; Simple; Compound; Triple Expansion; High Speed; Low Speed; Corliss; Vertical; Single-Acting. Condensers; Cooling Towers; Fly Wheel; Governors; Lubrication. De Laval and Parsons Turbines.

HEAT: Expansion of Gases; Efficiency of Actual Engine; Multiple Expansion; Jackets; Superheaters; Four-Valve Engines; Separators. Indicators; Actual and Theoretical M. E. P.

TESTING: Economy; Instruments: Indicators; Scales; Gages; Calorimeters; Brakes.

GAS PRODUCERS

GAS PRODUCERS: Introduction; Analysis; Gaseous Fuels; Manufacture; Operation; Fuel; Losses; Heat Balance; Classification; Types; Induced Draft Gas Producer; Suction Gas Producer; Bi-Product Gas Producer; Gas Cleaning; Uses; Gas Producer Power Plants; Steam Boilers; Ceramic Kilns; Metallurgical Furnaces; Conclusion.

GAS AND OIL ENGINES

GAS AND OIL ENGINES: External Combustion Motor; Internal Combustion Motor; Lenoir Gas Engine; Otto Cycle; Construction; Explosive Mixture; Operation; Exhaust; Valves; Pressures and Temperatures; Adiabatic Expansion; Work Done; Hot Tube Ignition; Jump Spark; Wipe Spark; Governing; Starting; Water Jacket; Coal Gas; Water Gas; Producer Gas; Fuel Consumption; Oil Engine; Gasoline Engine; Crude Oil Engine; Diesel Cycle.

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MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

MECHANICAL-ELECTRICAL ENGINEERING

SEE MECHANICAL ENGINEERING PAGE 48

CENTRAL STATION WORK

INCLUDING MECHANICAL DRAWING.

Prepared for Central Station Employes, Electricians, Testers, Linemen, Lamp Trimmers, Engineers, Firemen, Inspectors, Superintendents, Electrical Engineers, Students and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
*Metallurgy.
Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Types of Dynamo-Electric Machinery.
Management of Dynamo-Electric Machinery Part I.
Management of Dynamo-Electric Machinery Part II.
Storage Batteries.
Types of Boilers.
Boiler Accessories.
Steam Pumps.
Steam Engine Part I.
*Gas Producers.
*Gas Engines.
Indicators.
Valve Gears.
Electric Wiring.
Electric Lighting.
Electric Railways Part I.
Electric Railways Part II.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Electrical Measurements.
Alternating Current Machinery Part I.
Alternating Current Machinery Part II.
Alternating Current Machinery Part III.
Alternating Current Machinery Part IV.
Alternating Current Machinery Part V.
Alternating Current Machinery Part VI.
Power Stations.
Power Transmission.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
*Mechanical Drawing Part V.
*Mechanical Drawing Part VI.

*Optional.

Tuition $65.00. Payable Monthly.

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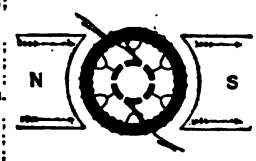
SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 106

ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E.M.F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.



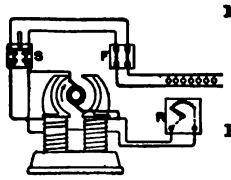
ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants.

THEORY OF DYNAMO-ELECTRIC MACHINERY: Symbols; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Types of Fields; Series, Shunt and Compound Windings.

DIRECT CURRENT DYNAMOS: Constant Current; Constant Potential; Characteristic Curves; External; Internal; Total. Long and Short Shunt. Magneto-motive Force; Magnetic Reluctance; Magnetizing Force. Field Magnets. Dynamo Construction: Armature; Armature Core and Windings; Binding Wires; Closed and Open Coil Armature Commutators; Brushes; Brush Holders; Field Magnets and Coils. Sparking. Installation. Operation. Testing.

DIRECT CURRENT MOTORS: Principles; Equations: Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Series Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

TYPES OF DYNAMO-ELECTRIC MACHINERY. DIRECT CURRENT. Classes; Methods of Driving; Types: General Electric; Crocker-Wheeler; Westinghouse; Bullock; C and C; Holtzer-Cabot, etc.: Electrolytic Work; Arc Lighting Generators; Railway Motors; Motor-Generators and Dyna-motors.



MANAGEMENT OF DYNAMO-ELECTRIC MACHINERY: Selection; Erection; Connection; Operation; Construction; Handling; Regulation; Foundations; Installation; Belts; Assembling; Wiring; Circuit Breakers; Circuits; Starting; Stopping; Generators in Parallel; Generators in Series; Three-wire System; Inspecting; Testing; Detection and Remedy of Troubles; Sparking; Heating; Railway Motors.

ELECTRIC WIRING: Wires; Coverings; Joints; Wiring Fixtures; Cleats; Casings; Tunnels; Switches; Plugs; Sockets; Fuses; Meters; Applications; Plans and Specifications; Fire Risks; Insurance Rules and Regulations; Inspectors.

STORAGE BATTERIES: Plante; Faure; Forming Plates; Setting up; Electrolyte; Tests; Discharging; Efficiency; Sulphating; Buckling; Disintegrating; Short Circuiting; Over Discharging; Uses; Connections; Diagrams; Switches; Regulation of Charging Generator; Boosters.

ELECTRIC LIGHTING: Lamps; Candle Power; Incandescent Lamps; Arc Lights; Systems of Distribution, Feeders; Potential; Location of Lamps; Power Required; Location and Equipment of Plant; Overhead and Underground Systems; Wiring of Buildings; Size of Wire; Calculations.

ELECTRIC RAILWAYS: Car Equipment; Armature Coils, Leads and Brushes. Inspection; Gearing; Lubrication; Bearings; Motor Suspension; Controllers and Car Wiring; Multiple Unit System; Car Heaters; Car Wiring; Resistances; Car Accessories; Air Brake; Magnetic Brake; Car Bodies; Overhead Construction; Feeders; High-Tension Lines; Third Rail; Conduit System; Track Construction; Electrolysis; Alternating Current Transmission; Power Station; Switch Boards; Alternating Current Systems; Operation; Testing; Faults.

ELECTRICAL MEASUREMENTS: Units, Symbols for Physical Quantities. Galvanometers; Rheostats; Voltmeters; Ammeters; Wattmeters; Measurement of Resistance. Locating Faults; E. M. F. of Alternating Currents, Calibration of Voltmeters and Ammeters, Measurement of Energy, Quantity and Capacity.

ALTERNATING-CURRENT MACHINERY: Simple Alternator; Alternating E. M. F. and Current; Armature Cores and Windings; Cycle; Average Values; Effective Values; Form Factor; Instantaneous and Average Power; Harmonic E. M. F. and Current; Synchronism and Phase Difference; Maximum and Effective Values; Expression for Power; Inductance; Capacity; Reactance; Impedance; Measuring Instruments; Armature Reaction; Alternator Regulation; Excitation; Alternators; Armature Winding; Types; Losses; Efficiencies; Ratings; Tests; Synchronous Motor; Transformer; Regulation; Tests. Rotary Converter; Power Ratings; Induction Motor; Motor Generator; Switch Boards and Station Appliances.

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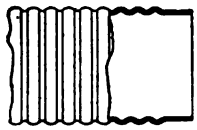
CENTRAL STATIONS: Location; Buildings; Machinery; Measuring Instruments; Switchboard; Starting; Stopping; Faults in Generators and Motors; Accumulators; Charging and Discharging; Troubles. Power Transmission: Line Loss; Direct and Alternating Current Systems; Voltages; Wiring; Transmission Lines; Losses; Illustrative Installations.

BOILERS

TYPES: Flue Boilers; Fire-Tube Boilers; Vertical; Fire Engine; Babcock and Wilcox; Heine; Almy; Cahall; etc. Marine and Locomotive Boilers.



FITTINGS: Furnaces; Mechanical Stokers; Fuel Economizers; Valves; Gages; Fusible Plugs; Traps; Pumps; Injectors.

DETAILS: Setting; Pipes and Pipe Coverings; Supports. Boiler Horsepower.

CORROSION AND INCRUSTATION: Deterioration; Explosions, Investigation.

FUELS: Kinds; Heat Values; Composition.

CARE AND MANAGEMENT: Fittings; Feed Water; Firing; Cleaning Fires; Testing.

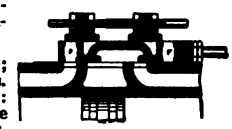
STEAM ENGINES

PUMPS: Principles; Kinds; Suction; Forcing; Valves; Design and Construction; Capacity; Sizes for Boiler Feed; Erection and Piping. Care; Valve Setting. Types.

STEAM ENGINES: Parts; Cylinder; Piston; Crank; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; High Speed; Low Speed; Corliss; Vertical; Single Acting. Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; De Laval and Parsons Turbines.

INDICATORS: Indicator Diagrams; Mean Effective Pressure; Watts Diagram; Watts Indicator; Crosby, Thompson and Tabor Indicators. Reducing Motions. Calculation of Horse Power from Diagrams; Table of Steam Engine Constants; Measuring Card.

DIAGRAMS: Ideal Cards; Actual Cards; Cards for Multi-Expansion Engines; Faults of Indicator Cards; Remedies. Calculation of Steam Consumption from Indicator Cards.



VALVE GEARS: Operation; Ports; Eccentric; Valve Diagrams; Zeuner Diagram; Designing the Slide Valve. Calculations. Setting: Equal Lead; Equal Cut Off. Reversing Gear: Stephenson; Gooch. Allen and Joy Gears. Piston; Double Ported; Trick; Double Gears; Corliss; Methods of Balancing.

MATHEMATICS

ALGEBRA AND GEOMETRY. SEE SYNOPSIS PAGE 169

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

ELECTRIC LIGHTING

A concise course prepared for Dynamo Tenders, Linemen, Wiremen, Lamp Trimmers, Stationary Engineers and Students.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Electric Wiring.
Electric Lighting.

Tuition $50.00. Payable Monthly.

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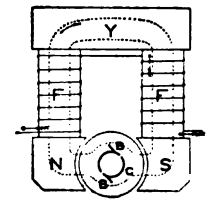
SYNOPSIS OF COURSE

MATHEMATICS

ARITHMETIC: Units; Numbers; Notation; Numeration; Value; Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.



DECIMALS: System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

PERCENTAGE: Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Measurement of Steam Space in a Horizontal Multitubular Boiler.

ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.

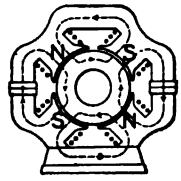
ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Types of Fields; Series, Shunt and Compound Windings.

DIRECT CURRENT DYNAMOS: Constant Current; Constant Potential; Series, Shunt and Compound Dynamos: Characteristic Curves: External; Internal; Total. Long and Short Shunt. Magneto-motive Force; Magnetic Reluctance; Magnetizing Force. Field Magnets. Dynamo Construction: Armature; Armature Core and Windings; Binding Wires; Closed and Open Coil Armatures; Commutators; Brushes; Brush Holders; Field Magnets and Coils. Sparking. Installation. Operation. Testing.

DIRECT CURRENT MOTORS: Principles; Equations; Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Series Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

ELECTRIC WIRING: Wire: Coverings; Standard Sizes; Insulating. Wire for High Voltage; Wire for Light and Power; Grades of Copper; Making Joints; Wiring Light Fixtures. Cleats, Casings and Tunnels; Wiring in Walls and Partitions. Standard Batteries; Care of Cells; Grouping for Bells, Telephone and Gas Lighting. Push Buttons; Annunciators; Bells; Gongs and Buzzers; Switches; Fuses; Meters; Burglar Alarms; Gas Lighters; Furnace Regulators. Wiring Plans; Sizes and Location of Wires; Returns, Fire Risks; Protection from Water; Insurance Rules and Regulations. Inspectors.



ELECTRIC LIGHTING: Definitions; Measurement of Candle Power; Bunsen Photometer; Incandescent Lamps; Efficiency; Life; Heating; Series Incandescent Lamps. Arc Lights: Principles; Carbons; Operation; Detail Parts.

SYSTEMS OF DISTRIBUTION: Series; Multiple Series; Parallel and Loop Systems; Feeders; Pilot Wires; Three and Five Wire Systems; Alternating Current System. Location of Lamps; Horse Power Required for Lighting. Plant: Location and Equipment. Conductors: Circular Mil. Overhead and Underground Systems. Details. Wiring Buildings: Calculations; Allowable Drop of Potential.

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ELECTRIC RAILWAYS

Prepared for Railway Superintendents, Motormen, Conductors, Linemen, Wiremen and Students.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Electric Wiring.
Electric Railways Part I.
Electric Railways Part II.

Tuition $50.00. Payable Monthly.

SYNOPSIS OF COURSE

MATHEMATICS

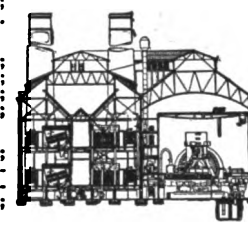
ARITHMETIC: Units; Numbers; Notation; Addition; Subtraction: Multiplication; Division; Factoring; Cancellation; Fractions; Decimals; Symbols of Aggregation; Percentage; Denominate Numbers; Tables of Linear and Square Measure; Tables of Weights; Involution; Evolution; Square Root; Cube Root; Roots of Fractions; Ratio; Proportion.

ELEMENTARY ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division; Cancellation; Equations; Transposition; Unknown Quantities.

MENSURATION: Lines; Angles; Polygons; Circles; Sectors and Segments. Measurement of Angles; Triangles; Rectangles; Trapezoids; Hexagons; Circles; Volumes and Surfaces of Prisms; Cylinders; Pyramids; Cones; Frustums; Sphere. Practical Problem. Measurement of Steam Space in a Horizontal Multitubular Boiler.

ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistence; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.



ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO-ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Fields; Series, Shunt and Compound Windings.

DIRECT CURRENT DYNAMOS: Constant Current; Constant Potential; Characteristic Curves; External; Internal; Total. Long and Short Shunt. Magneto-motive Force; Magnetic Reluctance; Magnetizing Force. Field Magnets. Dynamo Construction: Armature; Armature Core and Windings; Binding Wires; Closed and Open Coil Armature Commutators; Brushes; Brush Holders; Field Magnets and Coils. Sparking. Installation. Operation. Testing.

DIRECT CURRENT MOTORS: Principles; Equations; Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Series Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

ELECTRIC WIRING: Wires; Coverings; Joints; Wiring Fixtures; Cleats; Casings; Tunnels; Switches; Plugs; Sockets; Fuses; Meters; Applications; Plans and Specifications; Fire Risks; Insurance Rules and Regulations; Inspectors.

ELECTRIC RAILWAYS: Car Equipment; Armature Coils; Armature Leads and Brushes; Inspection; Gearing; Lubrication; Bearings; Motor Suspension; Controllers and Car Wiring; Magnetic Blow-out; Multiple Unit System; Car Heaters; Car Wiring; Resistances; Car Accessories; Trucks; Brakes; Air Brake; Magnetic Brake; Car Bodies; Overhead Construction; Trolley Wire; Feeders; High Tension Lines; Third Rail; Conduit System; Track Construction; Joints; Bonding and Return Circuits; Electrolysis; Power Supply and Distribution; Alternating Current Transmission; Power Station; Switch Boards; Alternating Current Systems; Operation; Testing; Faults.

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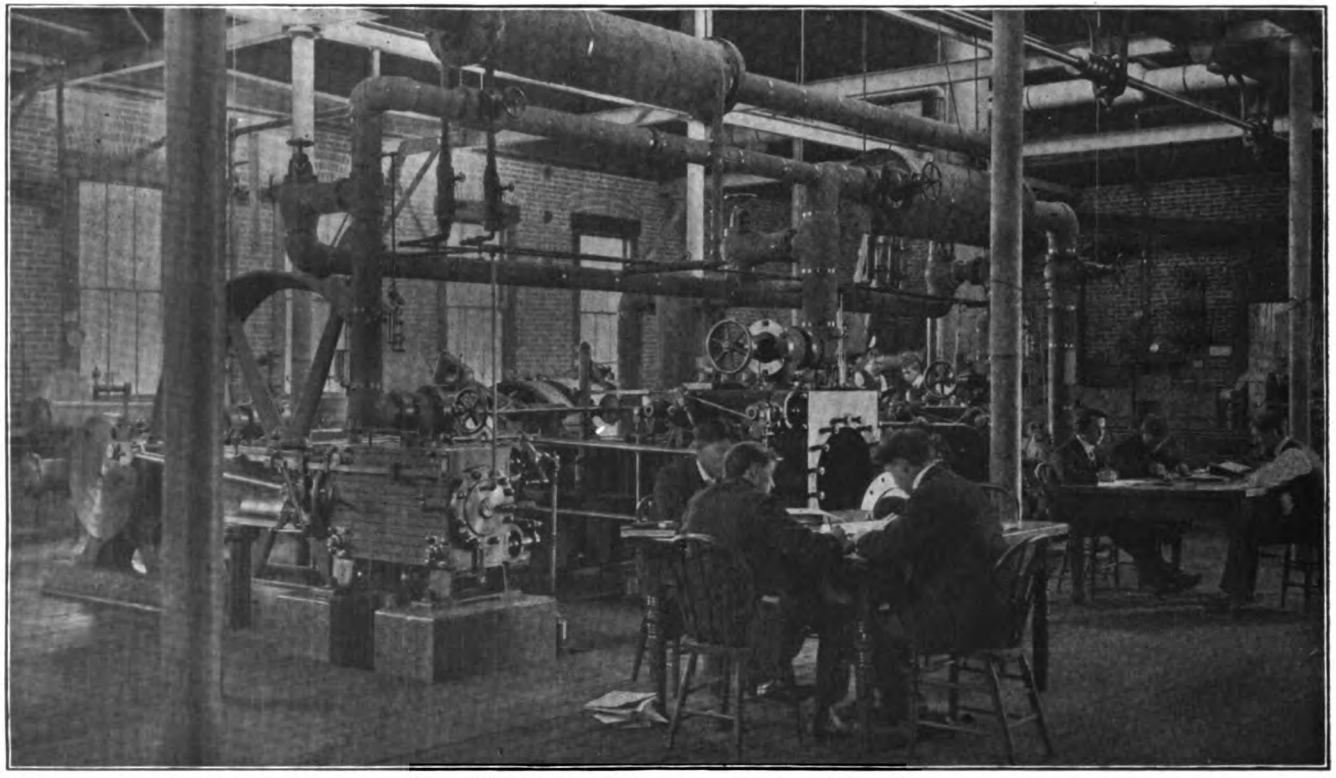

Steam Engineering Laboratory, Purdue University

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TELEPHONE PRACTICE

A complete, practical course for all those engaged in Telephone Work.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
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*Elements of Chemistry.
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The Electric Current.
*Theory of Dynamo-Electric Machinery.
Types of Dynamo-Electric Machinery.
Electrical Measurements.
Telephony Part I.
Telephony Part II.
Telephony Part III.
Telephony Part IV.
Telephony Part V.
Telephony Part VI.
Automatic Telephony.

*Optional.

Tuition $50.00. Payable Monthly.

SYNOPSIS OF COURSE

MATHEMATICS

ARITHMETIC: Units; Numbers; Notation; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation; Fractions; Decimals; Symbols of Aggregation; Percentage; Denominate Numbers; Tables of Linear and Square Measure; Tables of Weights; Involution; Evolution; Square Root; Cube Root; Roots of Fractions; Ratio; Proportion.

ELEMENTARY ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division; Cancellation; Equations; Transposition; Finding Value of Unknown Quantities.

MENSURATION: Lines; Angles. Polygons; Circles; Sectors and Segments. Measurement of Angles; Triangles; Rectangles; Trapezoids; Hexagons; Circles; Volumes and Surfaces of Prisms; Cylinders; Pyramids; Cones; Frustums; Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

HEAT

DEFINITION AND NOTATION: Definition of Heat; Amount of Heat; Degree of Heat; Thermometer: Temperature; Fahrenheit; Centigrade; Reaumur. Freezing and Boiling Points. Notation: Absolute Temperature; Changing from one Scale to another.

HEAT EFFECTS: Expansion: Cubical; Linear; Coefficients of Expansion; Expansion of Solids, Liquids and Gases. Liquefaction: Laws of Fusion; Table of Melting Points; Vaporization; Evaporation; Boiling; Table of Boiling Points; Boiling under Pressure and in Vacuum. Distillation; Conduction; Convection; Radiation.

THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

PRACTICAL APPLICATIONS: The Steam Engine and Hot-Air Engine; Manufacture of Ice; Production of Liquid Air.

ELEMENTS OF CHEMISTRY

FUNDAMENTAL PRINCIPLES: Physical and Chemical Changes; Mechanical Mixture; Molecules and Atoms.

ELEMENTS: Table of Elements with Symbols, etc. Atomic Weight; Vapor Density; Law of Definite Weight; Valence; Combining Value. Equations, Factors and Products. Saturated Solution.

PROPERTIES: Physical and Chemical Properties of Oxygen; Hydrogen; Nitrogen. Chemistry of Air and Water; Carbon: Forms and Compounds. Illuminating Gas; Water Gas; Coal Gas; Composition. Combustion: Carbon Monoxide; Carbon Dioxide.

METALS: Sodium: Properties; Compounds. Calcium: Properties; Compounds.

ACIDS: Manufacture of Sulphuric, Nitric and Hydrochloric Acids.

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ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.

ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Types of Fields; Series, Shunt and Compound Windings.

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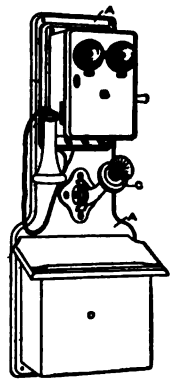

TELEPHONY

SOUND AND ELECTRICITY: Batteries; Alternating Currents; Induction; Electro-Static Capacity. Instruments: Signalling; Bells; Complete Telephone.

TELEPHONE LINES: Arrangements; Circuits; Distribution; Trunk, Toll and Subscriber Lines. Line Construction: Open Wire Lines; Materials; Poles; Fittings; Guying; Suspension Wire; Underground Cable Lines; Splicing and Pot Heading. Terminal Points; Distributing Points. Submarine Cable Lines. Transmission: Noisy Lines; Cross Talk; Retardation Coils; Pupin's Load Coils.

TELEPHONE EXCHANGE: Systems; Switchboards; Exchange Wiring; Circuits; Power Apparatus; Primary and Secondary Batteries; Charging Machine; Special Machines.

OPERATION AND MAINTENANCE: Systems; Local Calls; Trunk Calls; Toll Boards and Lines; Long Distance Switchboards. Direct and Party Lines; Code Signalling; B. W. C. System; Private Branch Exchanges. Common Battery System. Testing and Clearing Trouble; Wire Chief's Desk; Testing Circuits and Apparatus. Testing New Cables; Cutting into Service; Locating Faults; Replacing Defective Sections.

AUTOMATIC TELEPHONY: Strowger System; Operation; Connectors; Selectors; Switch; Wipers; Bank Multiples; Vertical Line; Rotary Line; Talking Circuit; Listening Circuit; Signaling Circuit; Series System; Bridge Cut-Off System.

THE ELECTRIC TELEGRAPH

A practical course prepared for all employes of Telegraph Companies.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
*Heat.
*Elements of Chemistry.
Elements of Electricity.
The Electric Current.
*Theory of Dynamo-Electric Machinery.
Types of Dynamo-Electric Machinery.
Electrical Measurements.
The Electric Telegraph Part I.
The Electric Telegraph Part II.
Wireless Telegraphy.

*Optional.

Tuition $25.00. Payable Monthly.

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SYNOPSIS OF COURSE

MATHEMATICS

ARITHMETIC: Units; Numbers; Notation; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation; Fractions; Decimals; Symbols of Aggregation; Percentage; Denominate Numbers; Tables of Linear and Square Measure; Tables of Weights; Involution; Evolution; Square Root; Cube Root; Roots of Fractions; Ratio; Proportion.

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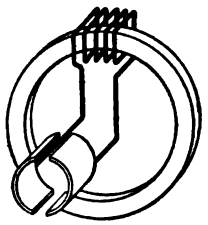
HEAT EFFECTS: Expansion: Cubical; Linear; Coefficients of Expansion; Expansion of Solids, Liquids and Gases. Liquefaction: Laws of Fusion; Table of Melting Points; Vaporization; Evaporation; Boiling; Table of Boiling Points; Boiling under Pressure and in Vacuum. Distillation; Conduction; Convection; Radiation.

THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

PRACTICAL APPLICATIONS: The Steam Engine and Hot-Air Engine; Manufacture of Ice; Production of Liquid Air.

ELEMENTS OF CHEMISTRY



FUNDAMENTAL PRINCIPLES: Physical and Chemical Changes; Mechanical Mixture; Molecules and Atoms.

ELEMENTS: Table of Elements with Symbols, etc. Atomic Weight; Vapor Density; Law of Definite Weight; Valence; Combining Value. Equations, Factors and Products. Saturated Solution.

PROPERTIES: Physical and Chemical Properties of Oxygen; Hydrogen; Nitrogen. Chemistry of Air and Water; Carbon: Forms and Compounds. Illuminating Gas; Water Gas; Coal Gas; Composition. Combustion: Carbon Monoxide; Carbon Dioxide.

METALS: Sodium: Properties; Compounds. Calcium: Properties; Compounds.

ACIDS: Manufacture of Sulphuric, Nitric, and Hydrochloric Acids.

ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.

ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Types of Fields; Series, Shunt and Compound Windings.

TYPES OF DYNAMO-ELECTRIC MACHINERY; DIRECT CURRENT. Classes; Methods of Driving; Types: General Electric; Crocker-Wheeler; Westinghouse; Bullock; C and C; Holtzer-Cabot, etc.; Electrolytic Work; Arc Lighting Generators; Railway. Motors; Motor-Generators and Dyna-motors.

ELECTRICAL MEASUREMENTS: Units, Symbols for Physical Quantities. Galvanometers; Rheostats; Voltmeters; Ammeters; Wattmeters; Measurement of Resistance. Locating Faults; E. M. F. of Alternating Currents. Calibration of Voltmeters and Ammeters, Measurement of Energy, Quantity and Capacity.

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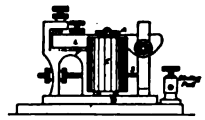
*THE ELECTRIC TELEGRAPH



EQUIPMENT OF SMALL OFFICE: Principles of the Electric Telegraph; The Local Circuit; Connecting Wires; Construction and Operation of Sounder. The Learner's Outfit; The Morse Code: Modes of Combining its Elements. Graded Exercises in Letters and Words; Faults of Beginners.

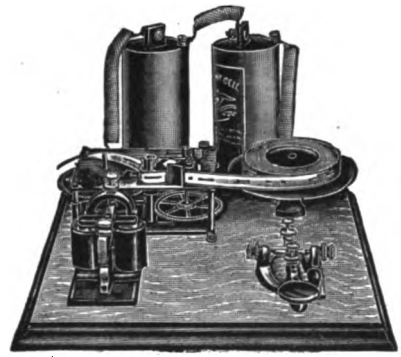
MAIN LINE CIRCUIT: The Relay; Description; Function. The Switchboard and its uses. Messages: Abbreviations; Cipher; Press Service; Code Telegraphy; The Phillips Code.

AUTO ALPHABET METHOD FOR LEARNERS.

RAILWAY TELEGRAPHY: Train Orders; Outfit of Intermediate Station; Ten-wire Switchboard; Devices in Local Circuits; The Dynamo for Main Line Work.

MULTIPLEX TELEGRAPHY: The Duplex: Magnetic Poles; Polar Relay; Pole Changes; Rheostat; Condenser. Quadruplex: Theory; Neutral Relay; Transmitter; The Tap and Leak Box; Troubles of the Quad. The Phonoplex.

WIRELESS TELEGRAPHY: History; Methods; Principles; Electric Waves; Resonance; Apparatus; Induction Coil; Relay; Keys; Coberer; Transformer; Detector; Systems.



Auto Alphabet Instrument.

The Auto Alphabet Instrument furnished with "The Electric Telegraph" is a complete learner's outfit; it automatically sends messages to the student, thus training his ear to an accurate style of sending and giving him practice in sending and receiving.

ALTERNATING CURRENT WORK

A complete, practical course in Alternating Current Work and Power Transmission designed for Graduates of this and other Technical Schools. Applicants must satisfy the School of their ability to proceed with the course.

INSTRUCTION PAPERS IN THE COURSE

Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Electrical Measurements.
Alternating Current Machinery Part I.
Alternating Current Machinery Part II.
Alternating Current Machinery Part III.
Alternating Current Machinery Part IV.
Alternating Current Machinery Part V.
Alternating Current Machinery Part VI.
Power Stations.
Power Transmission.

Tuition $50.00. Payable Monthly.

*NOTE: A nominal deposit is required for the apparatus loaned, which will be refunded when the instrument is returned in good condition.

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SYNOPSIS OF COURSE

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

ELECTRICAL MEASUREMENTS

INSTRUMENTS: Units; Symbols for Physical Quantities; Galvanometers; Rheostats; Voltmeters; Ammeters; Wattmeters.

MEASUREMENTS: Measurement of Resistance; Locating Faults; E. M. F. of Alternating Currents; Calibration of Voltmeters and Ammeters; Measurement of Energy, Quantity and Capacity.

ALTERNATING CURRENT MACHINERY

ALTERNATING CURRENTS: Advantages and Disadvantages; Laws; Graphic Representation; Form Factor; Instantaneous and Average Power; Harmonic E. M. F.; Inductance; Capacity; Fundamental Equation of the Alternating-Current Circuit; Resistance; Reactance; Impedance; Electric Resonance; E. M. F. Losses in Transmission Lines; Measuring Instruments.

ALTERNATORS: Fundamental Equation; Armature Reaction; Armature Inductance; Regulation; Field Excitation; Polyphase Alternators; Measurement of Power; Armature Windings; Single-, Two- and Three-Phase Windings; Commercial Types; Revolving Armature; Revolving Field; Inductor Alternators; Losses; Efficiencies; Ratings and Tests.

SYNCHRONOUS MOTORS: Starting; Torque and Power Output; Field Excitation and Power Factor; Tests.

THE TRANSFORMER: Physical Action; E. M. F. and Current Relations; Regulation; Connections; Parallel and Series; Commercial Types; Efficiency; Phase Transformation.

THE ROTARY CONVERTER: Starting; Uses; E. M. F. Relations; Hunting; Inverted Rotary; Control of Direct-Current Voltage; Field Excitation; Transformer Connections; Power Factor; Testing.

INDUCTION MOTORS: Windings; Torque and Speed; Efficiency; Starting; Typical Installations; Detailed Comparison of Synchronous and Induction Motors; Tests.

SWITCH-BOARD AND STATION APPLIANCES: Typical Switch-boards for Single,- Two- and Three-Phase Generators in Parallel; Connecting and Cutting out an Alternator in Parallel; Fuses; Feeder Regulators; Potential Regulators; Ratings of Voltage Regulators; The Voltmeter Compensator; Lightning Arresters; Tables.

POWER STATIONS

THE GENERATING STATION: Location; Selection of System; Size. The Steam Plant; Boilers; Arrangement; Foundations; Furnaces; Draft; Engines and Turbines. Hydraulic Plants; Water Turbines. Gas Engines; Efficiency. The Electrical Plant; Generators; Exciters; Transformers; Storage Batteries; Generator and Feeder Panels; Safety Devices.

SUBSTATIONS: Buildings; Equipment; Station Arrangement; Station Records; Methods of Charging for Power.

POWER TRANSMISSION

CONDUCTORS: Material; Resistance; Weight; Insulation; Distribution Systems; Series; Parallel; Series-Multiple and Multiple-series; Three-wire Systems. Regulation of Voltage; Alternating Current Distribution.

TRANSMISSION LINES: Capacity; Inductance; Calculation of Alternating-Current Lines; Formulae and Application; Practical Examples of Line Calculation. Overhead Lines; Location; Supports; Poles; Insulators; Pins; Stresses sustained by the Lines; Underground Construction; Solid, Trench and Drawing-in Systems; Earthenware Conduits; Cables; Selection of Voltage; Protection of Circuits.

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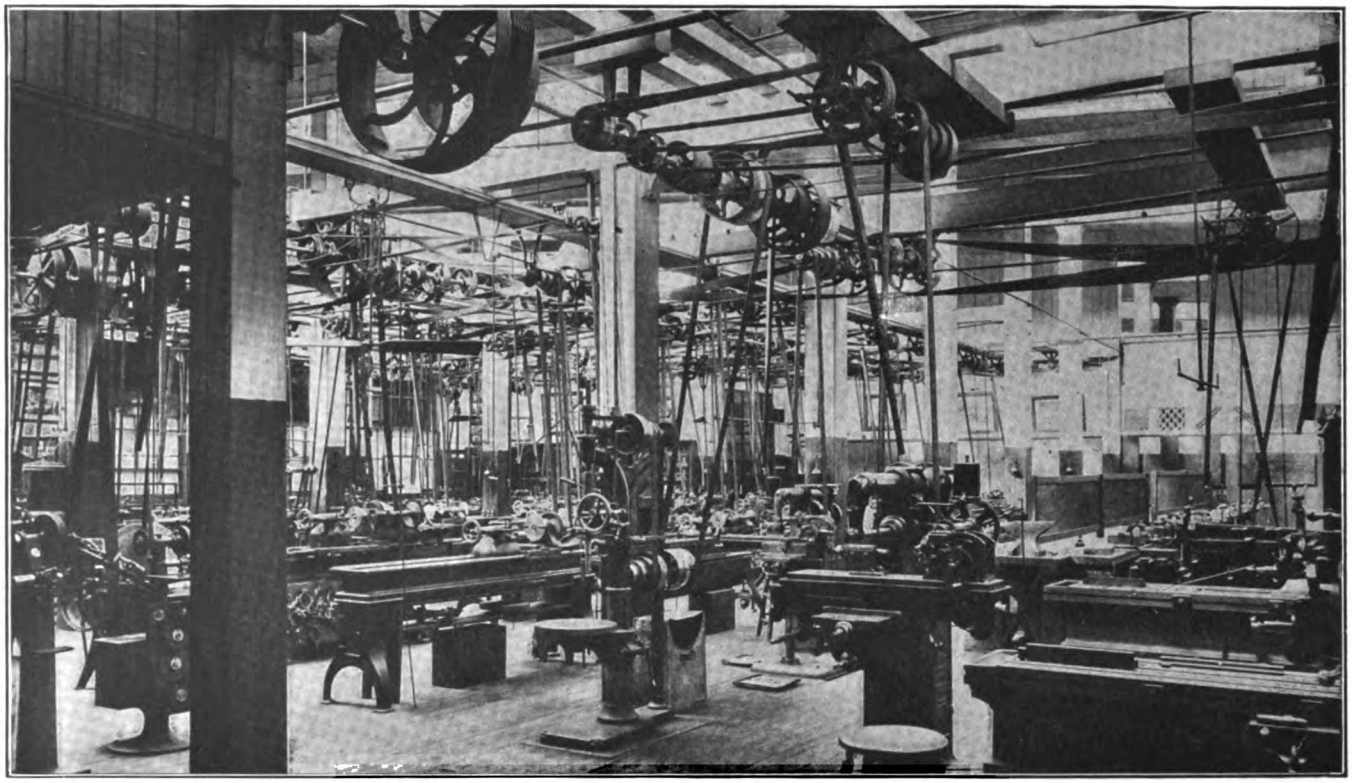

Machine Tool Laboratory, Massachusetts Institute of Technology

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DEPARTMENT OF

MECHANICAL ENGINEERING

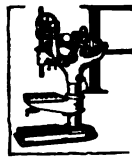
Partial list of the well-known authorities and educators who personally have prepared the instruction papers for correspondence study.

CHARLES L. GRIFFIN, S. B.,
Semet-Solvay Company.
EDWARD R. MARKHAM,
Harvard University.
WALTER B. SNOW, S. B.,
B. F. Sturtevant Company.
WILLIAM T. McCLEMENT, A. M.,
Armour Institute of Technology.
JAMES RITCHEY,
Armour Institute of Technology.
WILLIAM NEUBECKER,
New York Trade School.
FREDERICK W. TURNER,
Mechanic Arts High School, Boston.
WALTER S. LELAND, S. B.,
Mass. Institute of Technology.
ARTHUR L. RICE, M. M. E.,
Editor, "The Engineer."
ERVIN KENISON, S. B.,
Mass. Institute of Technology.
RALPH H. SWEETSER, S. B.,
The Algoma Steel Co., Ltd.
JOHN LORD BACON,
Lewis Institute.

COURSES

MECHANICAL ENGINEERING
MECHANICAL-ELECTRICAL ENGINEERING
SHEET METAL PATTERN DRAFTING
SHOP PRACTICE
BOILER MAKERS' COURSE
TOOL MAKERS' COURSE
SHEET METAL WORK
METAL ROOFING
CORNICE WORK
TINSMITHING

MECHANICAL ENGINEERING



PROBABLY no other branch of human knowledge has made such rapid progress during the last century as has Mechanical Engineering. Evidences of this are found in the improvement in the iron and steel industries, in agricultural implements, in textile machinery and in the creation of hundreds of new industries. The field of Mechanical Engineering is so broad that no one can expect to become expert in its whole extent. It includes steam engineering, the practical management of electrical machinery and the mechanic arts—pattern making, forging, foundry and machine shop work, tool making and sheet-metal work. This necessitates a division of the instruction; in this department special attention is given to the mechanic arts, leaving steam engineering to another department.

The general preliminary work—mathematics, the principles of machines, elementary chemistry and metallurgy—are the same in this

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course as in other branches of engineering. In addition to instruction in shop practice, the details of boilers and engines are discussed so that the mechanic working on steam machinery may know the relation of the parts to each other and to the whole machine.

In the Sheet-Metal Work, methods and principles are taught in a very thorough manner so that the student may take up new problems with little difficulty. As the laying out of patterns requires a working knowledge of intersections and developments, this portion of the course follows the study of projections in Mechanical Drawing.

MECHANICAL ENGINEERING COURSE

Prepared for Machinists, Toolmakers, Patternmakers, Moulders, Blacksmiths, Foundrymen, Builders of Boilers, Engines and General Machinery, Designers, Draftsmen, Engineers, Contractors, Superintendents and Foremen of Shops and Foundries.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Pattern Making Part I.
Pattern Making Part II.
Foundry Work Part I.
Foundry Work Part II.
Forging.
Machine Design Part I.
Machine Design Part II.
Steam Pumps.
Steam Engine Part I.
Indicators.
*Gas Producers.
*Gas Engines.
Valve Gears.
Steam Engine Part II.
Machine Shop Work Part I.
Machine Shop Work Part II.
Machine Shop Work Part III.
Tool Making Part I.
Tool Making Part II.
Tool Making Part III.
*Algebra Part I.
*Algebra Part II.
*Geometry.
*Trigonometry and Logarithms.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.
*Advanced Machine Design Part I.
*Advanced Machine Design Part II.
*Sheet Metal Work Part I.
*Sheet Metal Work Part II.

*Optional.

Tuition $70.00. Payable Monthly.

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SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 105

STEAM BOILERS

CONSTRUCTION OF BOILERS: Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; General Requirements; Grate Area; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Formulas for Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Uptake; Chimney.

TYPES OF BOILERS: Cornish; Lancashire; Galloway; Multitubular; Vertical Boilers; Manning; Fire Engine; etc. Water Tube Boilers: Babcock & Wilcox; Root; Heine; Almy; Belleville; Yarrow; Thorneycroft; Field. Marine and Locomotive Boilers.

BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels.

MACHINE DESIGN

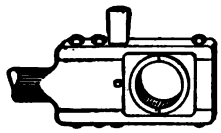
SEE SYNOPSIS PAGE 49

STEAM ENGINES

PUMPS: Principles; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves: Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank Crosshead; Valve; Eccentric. Types; Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping Accessories; Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine; De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power. Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards; Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies.



VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagrams; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy Valve Gears. Other Valves: Piston; Double Ported; Trick; Corliss. Methods of Balancing Valves.

ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter; Brake; Log of Test.

STEAM TURBINE: Steam Consumption, etc.

GAS PRODUCERS

GAS PRODUCERS: Introduction; Analysis; Gaseous Fuels; Manufacture; Operation; Fuel; Losses; Heat Balance; Classification; Types; Induced Draft Gas Producer; Suction Gas Producer; Bi-Product Gas Producer; Gas Cleaning; Uses; Gas Producer Power Plants; Steam Boilers; Ceramic Kilns; Metallurgical Furnaces; Conclusion.

GAS AND OIL ENGINES

GAS AND OIL ENGINES: External Combustion Motor; Internal Combustion Motor; Lenoir Gas Engine; Otto Cycle; Construction; Explosive Mixture; Operation; Exhaust; Valves; Pressures and Temperatures; Adiabatic Expansion; Work Done; Hot Tube Ignition; Jump Spark; Wipe Spark; Governing; Starting; Water Jacket; Coal Gas; Water Gas; Producer Gas; Fuel Consumption; Oil Engine; Gasoline Engine; Crude Oil Engine; Diesel Cycle.

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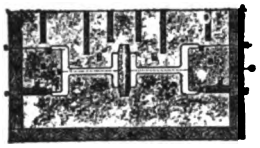
SHOP PRACTICE

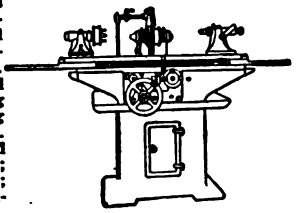
PATTERN MAKING: Material; Kinds of Wood; Warping; Twisting. Tools; Saw; Plane; Chisel; Gouge; Square; Gauges; Compasses; Calipers. Machines; Trimmer; Grindstone; etc. Molding: Construction of Pattern; Working from Drawings; Shrinkage; Draft; Rappage; Simple Patterns: Bushing; Finishing Patterns: Shellac; Sand Paper; Gluing; Hand Screws; Pulley; Segments; Hand Wheel; Metal Patterns; Engine Crank; Disc Crank; Lathe Chuck; Large Cylinders; Engine Cylinders; Globe Valve; Gear Wheels; Templates; Patterns for Bevel Gears; Columns.

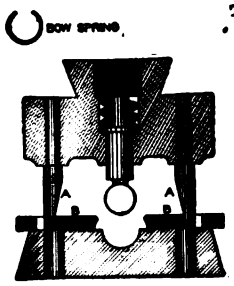


FOUNDRY WORK: Cupola; Charging; Blast; Flux; Preparation of Sand; Flasks; Loam; Binders. Tools: Shovel; Swab; Bellows; Rammer; Lifter; Smoother; etc. Molding: Molding Board; Drag; Pattern; Cope; Gating. Dry and open Sand Molding; Loam Molding; Loose Pieces. Gates and Gating. Venting and Pouring: Vent Wires; Ladles; Daubing. Grades of Iron: Pig; Forge Irons. Castings: Cooling; Cleaning; Effect of Shape. Gaggers; Chaplets; Molding Columns; Gears; Pulleys; Pipes; Cylinders; Steel Castings; Brass Work; Shop Management; etc.

FORGING: Wrought Iron; Steel; The Forge: Tuyeres; Fuel; Blast. Tools: Hammer; Anvil; Tongs; Chisels; Flatter; Swages; Punches; etc. Forging and Finishing: Staples; Bolts; Hooks; Tongs; Wrenches; etc. Tool Dressing. Welding and Tempering: Temperature; Scale; Flux; Scarfing; Butt and Lap Welding; Welding Steel to Wrought Iron. Annealing; Case Hardening; Brazing. Power Tools: Hammers; Punches; Shears; Drop Forges; Bolt Headers; Presses. Forging Shafts, Connecting Rods; Cranks; etc. Shop Suggestions: Shrinkage; Expansion.

MACHINE SHOP WORK: Hand Tools: Hammer; Center Punch; Surface Gauge; Scales; Calipers; Micrometer; Vernier Micrometer; Gauges; Chisels; Files and Filing; Drills; Reamers; Taps and Dies. Lathes and Tools; Chucks; Dogs; Mandrels; Centering; Turning Tools; Turning; Tool Posts; Boring Tools; Cutting Speed; Grinding; Turning a Taper; Taper Attachment; Eccentric Turning. Boring. Boring Bars. Screw Cutting; Tools; Lead Screw; Gears; Compound Lathe; Chasing. Drilling in Lathe; Chucks. Drill Press; Drilling; Holding Work. Planer: Tools; Holding Work. Plate Planer. Shaper and Slotter. Milling Machine. Mills; Speed of Mills; Tables; Interchangeable Work. Grinding; Laying out Work; Shop Suggestions; Surface Plate; Drilling Hard Metals; Fitting Brasses; Fluting Rollers; Pickling; Lining up Shafting.





TOOL MAKING: Measuring Instruments; Annealing, Hardening, and Grinding Twist Drills. Reamers: Kinds; Cutting Edges; Straightening; Grinding; Adjustable Reamers; Reamer Holders. Expanding Mandrels; Eccentric Arbors; Milling Machine Arbors. Taps: Flutes; Hardening; Screw Die Hobs; Releasing Tap Holders. Screw Cutting Dies: Cutting Edges; Clearance; Spring Screw Threading Dies. Die Holders. Counterbores: Facing Tool with Inserted Cutter; Inserted Pilots; Combination Counterbores. Hollow Mills. Forming Tools: Holders. Milling Cutters: Teeth; Hardening and Grinding Hole to Size; Interlocking, Nicked and Inserted Teeth; End Mills; Spiral Mills; T-slot Cutters; Drill Jigs; Slab Jigs; Bushings; Legs; Leaf; Box Jigs. Punch and Die Work: Guide; Stripper; Gauge Pin; Shear. The Punch: Laying Out; Shear; Locating Pins; Bending Dies; Forming Dies. Gauges: Accuracy; Grinding; Lapping.

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 159

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

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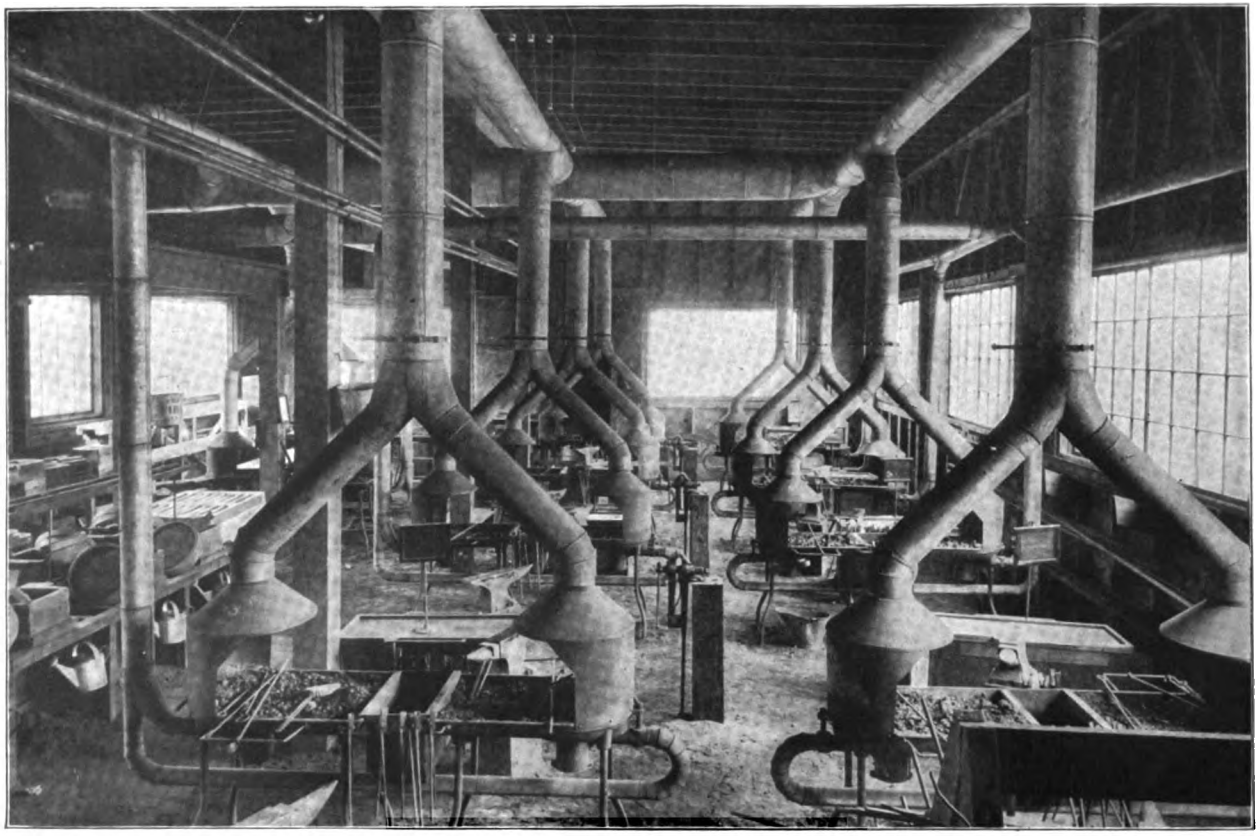

Forge Shop, Power House, Tufts College, Mass.

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MECHANICAL-ELECTRICAL ENGINEERING COURSE

INCLUDING MECHANICAL DRAWING

Prepared for Electricians, Superintendents and Foremen of Engineering Plants, Machinists, Iron Workers, Inspectors, Designers, Draftsmen, Builders of Machinery, Instructors, Students, and others who desire a thorough knowledge of the Mechanical-Electrical Field.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Elements of Electricity.
The Electric Current.
Machine Design Part I.
Machine Design Part II.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Types of Dynamo-Electric Machinery.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Steam Pumps.
Steam Engine Part I.
Indicators.
Steam Engine Part II.
Pattern Making Part I.
Pattern Making Part II.
Foundry Work Part I.
Foundry Work Part II.
Forging.
Machine Shop Work Part I.
Machine Shop Work Part II.
Machine Shop Work Part III.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Electrical Measurements.
Alternating Current Machinery Part I.
Alternating Current Machinery Part II.
Alternating Current Machinery Part III.
Alternating Current Machinery Part IV.
Alternating Current Machinery Part V.
Alternating Current Machinery Part VI.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.
*Advanced Machine Design Part I.
*Advanced Machine Design Part II.
*Gas Producers.
*Gas Engines.

*Optional.

Tuition $70.00. Payable Monthly.

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SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 166

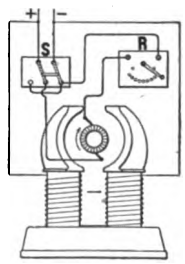
ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.

ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO-ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Types of Fields; Series, Shunt and Compound Windings.

DIRECT CURRENT DYNAMOS: Constant Current; Constant Potential; Series, Shunt and Compound Dynamos: Characteristic Curves: External; Internal; Total. Long and Short Shunt. Magneto-motive Force; Magnetic Reluctance; Magnetizing Force. Field Magnets. Dynamo Construction: Armature; Armature Core and Windings; Binding Wires; Closed and Open Coil Armatures; Commutators; Brushes; Brush Holders; Field Magnets and Coils. Sparking. Installation. Operation. Testing.



DIRECT CURRENT MOTORS: Principles; Equations; Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Series Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

TYPES OF DYNAMO-ELECTRIC MACHINERY. DIRECT CURRENT. Classes; Methods of Driving; Types: General Electric; Crocker-Wheeler; Westinghouse; Bullock; C and C; Holtzer-Cabot, etc.; Electrolytic Work; Arc Lighting Generators; Railway Motors; Motor-Generators and Dyna-motors.

ELECTRICAL MEASUREMENTS: Units; Symbols for Physical Quantities. Galvanometers; Rheostats; Voltmeters; Ammeters; Wattmeters; Measurement of Resistance. Locating Faults; E. M. F. of Alternating Currents, Calibration of Voltmeters and Ammeters. Measurement of Energy, Quantity and Capacity.

ALTERNATING CURRENT MACHINERY: Types of Alternators; Connections; Excitation; Regulation; Driving; Testing. Synchronous Motors; Starting; Torque; Output. Induction Motors: Operation; Condensers: Typical Installations. Transformers: Vector Diagrams; Phase; Losses; Connecting; Protective Devices; Special Types. Synchronous Converters: Rotary; Theory; Windings; Voltages; Excitation; Limit of Frequency; Special Apparatus.

MACHINE DESIGN

DEFINITION AND RELATION: Theoretical and Commercial Considerations; Invention; Original Design; Handbooks; General Reference Books; Empirical Data; Calculations; Notes; Records.

CONSTRUCTIVE MECHANICS AND DESIGN: Forces; Moments; Beams. Tension; Compression; Torsion; Friction and Lubrication. Working Stresses; Strains. Analysis of Conditions and Forces; Theoretical Construction; Practical Modification; Delineation and Specification.

APPLICATION TO POWER TRANSMISSION: Speed Ratio; Power; Load; Efficiency; Preliminary Calculation; Layout; Design of Parts; Belts; Pulleys; Shafts; Gears. Couplings; Clutches; Brakes. Bearings; Brackets; Stands; Bolts; Nuts; Screws; Keys; Pins; Cotters.

SIMPLE MACHINE ELEMENTS: Types; Materials; Shop Machinery; Processes; Construction; Cost; Competition; Machinery Market.

PLATES: Working Detail Drawings of Parts in a Practical Case of Power Transmission.

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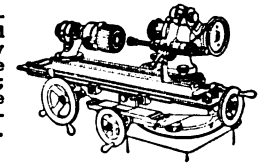
STEAM BOILERS

CONSTRUCTION OF BOILERS: Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; General Requirements; Grate Area; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Formulas for Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Uptake; Chimney.

TYPES OF BOILERS: Cornish; Lancashire; Galloway; Multitubular; Vertical Boilers; Manning; Fire Engine; etc. Water Tube Boilers: Babcock & Wilcox; Root; Heine; Almy; Belleville; Yarrow; Thornycroft; Field. Marine and Locomotive Boilers.

BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Factors of Evaporation; Corrosion and Incrustation; Explosions. Composition and Heat Value of Fuels. Care of Boilers.



SHOP PRACTICE

PATTERN MAKING: Material; Kinds of Wood; Warping; Twisting. Tools; Saw; Plane; Chisel; Gouge; Square; Gauges; Compasses; Calipers. Machines; Trimmer; Grindstone; etc. Molding: Construction of Pattern; Working from Drawings; Shrinkage; Draft; Rappage; Simple Patterns: Bushing; Finishing Patterns: Shellac; Sand Paper; Gluing; Hand Screws; Pulley; Segments; Hand Wheel; Metal Patterns; Engine Crank; Disc Crank; Lathe Chuck; Large Cylinders; Engine Cylinders; Globe Valve; Gear Wheels; Templates; Patterns for Bevel Gears; Columns.

FOUNDRY WORK: Cupola; Charging; Blast; Flux; Preparation of Sand; Flasks; Loam; Binders. Tools: Shovel; Swab; Bellows; Rammer; Lifter; Smoother; etc. Molding: Molding Board; Drag; Pattern; Cope; Gating. Dry and Open Sand Molding; Loam Molding; Loose Pieces. Gates and Gating. Venting and Pouring: Vent Wires; Ladles; Daubing. Grades of Iron: Pig; Forge Irons. Castings: Cooling; Cleaning; Effect of Shape. Gaggers; Chaplets; Molding Columns; Gears; Pulleys; Pipes; Cylinders; Steel Castings; Brass Work; Shop Management; etc.

FORGING: Wrought Iron; Steel; The Forge: Tuyeres; Fuel; Blast. Tools: Hammer; Anvil; Tongs; Chisels; Flatter; Swages; Punches; etc. Forging and Finishing: Staples; Bolts; Hooks; Tongs; Wrenches; etc. Tool Dressing. Welding and Tempering: Temperature; Scale; Flux; Scarfing; Butt and Lap Welding; Welding Steel to Wrought Iron. Annealing; Case Hardening; Brazing. Power Tools: Hammers; Punches; Shears; Drop Forges; Bolt Headers; Presses. Forging Shafts, Connecting Rods; Cranks; etc. Shop Suggestions: Shrinkage; Expansion.

MACHINE SHOP WORK: Hand Tools; Hammer; Center Punch; Surface Gauge; Scales; Calipers; Micrometer; Vernier Micrometer; Gauges; Chisels; Files and Filing; Drills; Reamers; Taps and Dies. Lathes and Tools; Chucks; Dogs; Mandrels; Centering; Turning Tools; Turning; Tool Posts; Boring Tools; Cutting Speed; Grinding; Turning a Taper; Taper Attachment; Eccentric Turning. Boring. Boring Bars. Screw Cutting; Tools; Lead Screw; Gears; Compound Lathe; Chasing. Drilling in Lathe; Chucks. Drill Press; Drilling; Holding Work. Planer: Tools; Holding Work. Plate Planer. Shaper and Slotter. Milling Machine. Mills; Speed of Mills; Tables; Interchangeable Work. Grinding; Laying out Work; Shop Suggestions; Surface Plate; Drilling Hard Metals; Fitting Brasses; Fluting Rollers; Pickling; Lining up Shafting.

STEAM ENGINES

PUMPS: Principles; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves: Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principles Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank Crosshead; Valve; Eccentric. Types; Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping Accessories; Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine; De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power. Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards; Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption from Card.

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ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter; Brake; Log of Test.

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

SHEET METAL PATTERN DRAFTING

INCLUDING MECHANICAL DRAWING

A complete practical course in Sheet Metal Work and Drafting prepared for all classes of Sheet Metal Workers, Roofers, Contractors, Tinsmiths, Plumbers, etc.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Tinsmithing.
Sheet Metal Work Part I.
Sheet Metal Work Part II.
Metal Roofing.
Cornice Work.
*Algebra Part I.
*Algebra Part II.
*Geometry.
*Trigonometry and Logarithms.
*Mechanical Drawing Part IV.
*Mechanical Drawing Part V.
*Mechanical Drawing Part VI.

*Optional.

Tuition $55.00. Payable Monthly.

SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 166

MECHANICAL DRAWING

PARTS I, II AND III

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates: Exercises.

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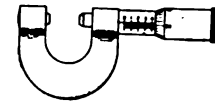
GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterials; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustrums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-eight Problems in Geometrical Drawing.



PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.

LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

SHEET METAL WORK

TINSMITHING. Principles and Methods of Construction; Tables; Capacity of Vessels; Shop Tools; Methods of Obtaining Patterns; Joints; Intersections and Developments: Prisms; Cylinders; Cones; Pyramids. Practical Tinware Problems: Short Rules; Allowance for Seaming and Wiring; Notching the Patterns; Transferring Patterns. Patterns for Pail, Funnel, Scoop, Pan, Coffee Pot, Foot Bath, Wash Boiler, Quart Measure, Scale Scoop, Dust Pan and Colander. Plates: Problems involving Intersections and Developments of Cones and Cylinders. Pattern for Oil Tank.

SHEET METAL WORK: Tables; Tools; Methods of Obtaining Patterns; Intersections and Developments. Approximate Developments. Circular Molds. Practical Shop Problems: Bathtub, Hip Bath, Funnel Strainer, Pail, Sink Drainer, Ventilator, Elbows in Round, Square and Oval Pipes, Tapering Elbows in Round and Square Pipes, Tapering Elbow Round to Oval, Rain-water Cut-off, Transition Piece in Rectangular Pipe, Curved Rectangular Chute, Hopper Register Box, Transition Piece from Round Base to Round Top placer Vertically. Offset Round to Oval, Threeway Branch Round to Round, Two-branch Fork Oval to Round, Tapering Flange Around Pipe Passing Through an Inclined Roof. Round Pipe Intersecting Conical Furnace Top; to One Side of Center of Top, Sphere, Ogee Basin, Brewer's Kettle, Moulded Cap on Stack, Elbows in Heavy Metal, Intersecting Pipes in Boiler Work, Gusset Sheet on Boiler, Scroll Signs in Heavy Metal.

METAL ROOFING: Skylight Work: Tables; Tools; Patterns; Shapes of Bars and Curbs; Pitch; Hipped; Turrets; Conservatory; Photographic; Extension; Louvred. Ventilator; Curb; Hip Bar; Length of Bars. Coverings: Mensuration; Preparing Sheets; Laying; Base Flashings; Cap Flashings; Solder; Roof Flashing for Soil Pipes; Standing Seam Roofing: Locking Sheets; Preparing Roll; Bending; Cleats; Seaming; Finishing; Eaves and Ridge; Counter Flashing; Corrugated Roofing and Siding: Tables; Fastening Wood to Iron; Laying a Valley; Flashing Around Chimneys and Smokestack. End Wall Flashings. Ridge Rolls; Sidings and Awnings; Shapes of Flat Casings.

CORNICE WORK: Shop Tools; Molding; Miters; Molding on Plane and Curved Surfaces; Square Panel Miter; Triangular Panel Miter; Miters of Different Profiles; Molding Intersecting Pilaster. Gable Molding: Square Turret; Horizontal Returns at Top and Foot of Segmental Pediment. Gable Molding; Gutter Miters; Moldings with Different Projections; Star; Hip Ridge Miter; Eyebrow Dormer; Bay Window. Curved Moldings: Principles; Plane Flare; Cove Mold; Ogee Mold; Bead; Bottom of Circular Bay; Molding curved in Plan and in Elevation. Bull's-Eye Window.

MECHANICAL DRAWING

PARTS IV, V AND VI

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads, Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for Solutions for Blue-Print Paper. Plates.

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WORKING SHOP DRAWINGS: Plan and Scope of Advanced Work; Essentials; Completeness of Drawings; Cost of Producing; Method of Procedure.

DUPLEX PUMP PLATES: Rating of Pump; Steam-End Layout; Moulding and Machining of Steam End. Dimensions and Letters; System; Accuracy; Clearness; Completeness; Character; Inking and Tracing: Dimensions; Abbreviations; Piston Rod and Valve Stem; Molding and Machining; Steam Chest and Valve; Valve-Motion Layout and Details; Yoke; Stuffing Boxes; Brackets; Water-end Layout; Water Cylinder; Cap; Air Chamber; Plunger; Valve Details; Foundation; General Drawing.

ORDER SHEETS: List of Castings and Miscellaneous Parts: Bolts; Nuts; Pins; Special Fittings; Wrenches. Plates.

DETAILED DRAWINGS: The Helix; Pitch; Springs; Conventional Representations; V-Thread; Square Thread; Standard Threads. Cams: Kinds of Motion; Designing.

GEARING: Belt: Parallel Shafts; Open and Crossed Belts; Quarter-Turn Belt; Reversible Quarter-Turn Belt with Two Guide Pulleys; With One Guide Pulley. Belts Connecting Non-Parallel Shafts whose Axes Intersect. Belt Holes, Tooth Gearing: Pitch Circles; Addendum; Back Lash; Diametrical Pitch; Cycloidal and Involute Gears; Epicycloidal Spur Gears. Annular Gears; Rack and Pinion; Involute Gears; Bevel Gears. Plates.

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

SHOP PRACTICE COURSE

INCLUDING MECHANICAL DRAWING

A short practical course prepared for Machinists, Toolmakers, Patternmakers, Blacksmiths, Foundry-men, Designers, Draftsmen, Inventors, Builders of all kinds of Machinery, Superintendents and Foremen in all branches of Engineering, Instructors and Students.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
*Mechanical Drawing Part V.
*Mechanical Drawing Part VI.
Metallurgy.
Machine Shop Work Part I.
Machine Shop Work Part II.
Machine Shop Work Part III.
Toolmaking Part I.
Toolmaking Part II.
Toolmaking Part III.
Pattern Making Part I.
Pattern Making Part II.
Foundry Work Part I.
Foundry Work Part II.
Forging.

*Optional.

Tuition $50.00. Payable Monthly.

Note.—Last five subjects sent in any order, as requested.

SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

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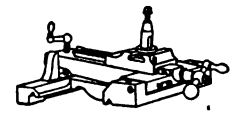
FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction, Multiplication and Division of Fractions.



DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight: Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

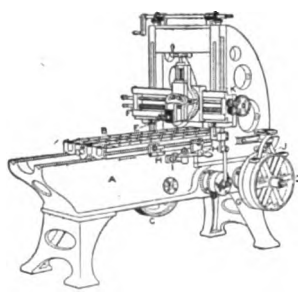
ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

METALLURGY

IRON AND STEEL: Ores: Magnetite; Hematite; Limonite; Sederite. Minerals: Iron Pyrites; Franklinite. Preparation of Ores.



BLAST FURNACE: Ores; Flux; Fuel; Slag. Operation and Chemistry of Furnace. Cast Iron: Grades and Impurities. Malleable Cast Iron.

WROUGHT IRON: Direct Process; Puddling Process; Operation of Furnace. Welding.

STEEL: Blister Steel; Crucible Steel; Bessemer Process: Converter; Acid and Basic Bessemer; Cupola Process; Molds and Molding. Rails. Open Hearth Process; Martin Process; Siemens Process; Combination; Gas Producers. Special Steels; Casehardening; Effects of Elements in Steel; Tempering: Colors and Temperature.

OTHER METALS: Copper: Ores; Extraction; Smelting; Refining. Lead: Smelting; Softening and Desilverizing; Refining. Tin. Zinc. Aluminum. Tables of Properties of Metals and Alloys.

SHOP PRACTICE

MACHINE SHOP WORK: Hand Tools; Hammer; Center Punch; Surface Gauge; Scales; Calipers; Micrometer; Vernier Micrometer; Gauges; Chisels; Files and Filing; Drills; Reamers; Taps and Dies. Lathes and Tools; Chucks; Dogs; Mandrels; Centering; Turning Tools; Turning; Tools Posts; Boring Tools; Cutting Speed; Grinding; Turning a Taper; Taper Attachment; Eccentric Turning. Boring. Boring Bars. Screw Cutting; Tools; Lead Screw; Gears; Compound Lathe; Chasing. Drilling in Lathe; Chucks. Drill Press; Drilling; Holding Work. Planer: Tools; Holding Work. Plate Planer. Shaper and Slotter. Milling Machine. Mills; Speed of Mills; Tables; Interchangeable Work. Grinding; Laying out Work; Shop Suggestions; Surface Plate; Drilling Hard Metals; Fitting Brasses; Fluting Rollers; Pickling; Lining up Shafting.

TOOL MAKING: Measuring Instruments; Annealing, Hardening, and Grinding Twist Drills. Reamers: Kinds; Cutting Edges; Straightening; Grinding; Adjustable Reamers; Reamer Holders. Expanding Mandrels; Eccentric Arbors; Milling Machine Arbors. Taps: Flutes; Hardening; Screw Die Hobs; Releasing Tap Holders. Screw Cutting Dies: Cutting Edges; Clearance; Spring Screw Threading Dies. Die Holders. Counterbores: Facing Tool with Inserted Cutter; Inserted Pilots; Combination Counterbores. Hollow Mills. Forming Tools: Holders. Milling Cutters: Teeth; Hardening and Grinding Hole to Size; Interlocking, Nicked and Inserted Teeth; End Mills; Spiral Mills; T-slot Cutters; Drill Jigs; Slab Jigs; Bushings; Legs; Leaf; Box Jigs. Punch and Die Work: Guide; Stripper; Gauge Pin; Shear. The Punch: Laying Out; Shear; Locating Pins; Bending Dies; Forming Dies. Gauges: Accuracy; Grinding; Lapping.

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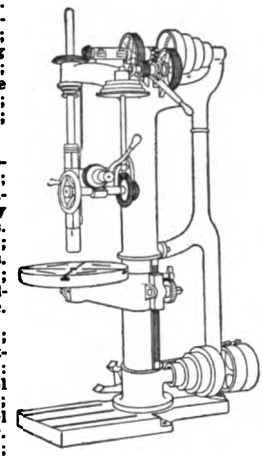
PATTERN MAKING: Material; Kinds of Wood; Warping; Twisting. Tools; Saw; Plane; Chisel; Gouge; Square Gauges; Compasses; Calipers. Machines; Trimmer; Grindstone, etc. Molding: Construction of Pattern; Working from Drawings; Shrinkage; Draft; Rappage; Simple Patterns: Bushing; Finishing Patterns: Shellac; Sand Paper; Gluing; Hand Screws; Pulley; Segments; Hand Wheel; Metal Patterns; Engine Crank; Disc Crank; Lathe Chuck; Large Cylinders; Engine Cylinders; Globe Valve; Gear Wheels; Templates; Patterns for Bevel Gears; Columns.



FOUNDRY WORK: Cupola; Charging; Blast; Flux; Preparation of Sand; Flasks; Loam; Binders. Tools: Shovel; Swab; Bellows; Rammer; Lifter; Smoother; etc. Molding: Molding Board; Drag; Pattern; Cope; Gating. Dry and Open Sand Molding; Loam Molding; Loose Pieces. Gates and Gating. Venting and Pouring: Vent Wires; Ladles; Daubing. Grades of Iron: Pig; Forge Irons. Castings: Cooling; Cleaning; Effect of Shape. Gaggers; Chaplets; Molding Columns; Gears; Pulleys; Pipes; Cylinders; Steel Castings; Brass Work; Shop Management; etc.

FORGING: Wrought Iron; Steel; The Forge: Tuyeres; Fuel; Blast. Tools: Hammer; Anvil; Tongs; Chisels; Flatter; Swages; Punches; etc. Forging and Finishing: Staples; Bolts; Hooks; Tongs; Wrenches; etc. Tool Dressing. Welding and Tempering: Temperature; Scale; Flux; Scarfing; Butt and Lap Welding; Welding Steel to Wrought Iron. Annealing; Case Hardening; Brazing. Power Tools: Hammers; Punches; Sheares; Drop Forges; Bolt Headers; Presses. Forging Shafts, Connecting Rods; Cranks; etc. Shop suggestions: Shrinkage; Expansion.

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

BOILERMAKERS' COURSE

A short course prepared for Boiler Makers, including instruction in Arithmetic, Mensuration and Mechanical Drawing.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Sheet Metal Work Part I.
Sheet Metal Work Part II.
Construction of Boilers.
Types of Boilers.

Tuition $25.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

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DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight: Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

MECHANICS

PROPERTIES OF MATTER: Atoms and Molecules; Solids; Liquids; Gases; Extensibility; Impenetrability; Indestructibility; Inertia; Divisibility; Porosity; Hardness; Tenacity; Brittleness; Malleability; Ductility.

MOTION, VELOCITY AND FORCE: Momentum; Newton's Laws; Parallelogram of Forces; Force Diagrams. Center of Gravity; Falling Bodies; Projectiles; The Pendulum; Kinetic and Potential Energy; Centrifugal Force.

PRINCIPLES OF MACHINES: Levers; Pulleys; Inclined Planes; Wedges; Screws; Laws of Friction; Coefficients of Friction. Tooth Gears: Spur; Worm; Bevel; Helical; Belt, Wire and Rope Gearing. Velocity Ratio; Horse Power Transmitted.

STRENGTH OF MATERIALS: Cohesion; Adhesion; Capillarity; Stress; Deformation; Elastic Limit; Breaking Strength; Coefficient of Elasticity; Tension; Compression; Shear; Torsion; Factor of Safety; Working Stress. Strength of Pipes and Cylinders; Strength of Beams and Columns; Moment of Inertia; Diagrams and Formulas.

HYDROSTATICS: Density; Specific Gravity; Hydrometers; Pressure of Fluids; Hydraulic Press; Head; Pressure; Dams and Gates; Coefficients; Water Motors; Turbines.

PNEUMATICS: Barometers; Mariotte's Law; Suction Pumps.

METALLURGY

IRON AND STEEL: Ores: Magnetite; Hematite; Limonite; Siderite. Minerals: Iron Pyrites; Franklinite. Preparation of Ores.

BLAST FURNACE: Ores; Flux; Fuel; Slag. Operation and Chemistry of Furnace. Cast Iron; Grades and Impurities. Malleable Cast Iron.

WROUGHT IRON: Direct Process; Puddling Process; Operation of Furnace. Welding.

STEEL: Blister Steel; Crucible Steel; Bessemer Process: Converter; Acid and Basic Bessemer; Cupola Process; Molds and Molding. Rails. Open Hearth Process: Martin Process: Siemens Process; Combination; Gas Producers. Special Steels; Casehardening; Effects of Elements in Steel; Tempering: Colors and Temperature.

OTHER METALS: Copper: Ores; Extraction; Smelting; Refining. Lead: Smelting; Softening and Desilverizing; Refining. Tin. Zinc. Aluminum. Tables of Properties of Metals and Alloys.

MECHANICAL DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises in Line Work.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordiates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.

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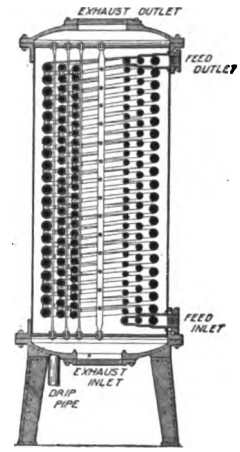
LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads, Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for solutions for Blue-Print Paper. Plates.

SHEET METAL WORK



CONSTRUCTION: Tables; Shop Tools;; Methods of Obtaining Patterns.

INTERSECTION AND DEVELOPMENTS: Prisms and Cylinders; Quadrangular Prism and Sphere. Development by Triangulation; Scalene Cone; Irregular Solids. Approximate Developments. Circular Molds.

PRACTICAL SHOP PROBLEMS: Bathtub, Hip Bath, Funnel Strainer, Pail, Sink Drainer, Ventilator, Elbows in Round, Square and Oval Pipes. Tapering Elbows in Round and Square Pipes, Tapering Elbow Round to Oval, Rain-Water Cut-Off, Transition Piece in Rectangular Pipe, Curved Rectangular Chute, Hopper Register Box, Transition Piece from Round Base to Round Top placed Vertically, Offset Round to Oval, Three-way Branch Round to Round, Two-Branch Fork Oval to Round, Tapering Flange Around Pipe Passing through an Inclined Roof, Round Pipe Intersecting Conical Furnace Top; to One Side of Center of Top, Sphere, Ogee Basin, Brewer's Kettle, Moulded Cap on Stack, Elbows in Heavy Metal, Intersecting Pipes in Boiler Work, Gusset Sheet on Boiler, Scroll Signs in Heavy Metal.

STEAM BOILERS

CONSTRUCTION OF BOILERS. Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; General Requirements; Grate Area; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Uptake; Chimney.

TYPES OF BOILERS. Cornish; Lancashire; Galloway; Multitubular; Vertical Boilers; Manning; Fire Engine; etc. Water Tube Boilers: Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Yarrow; Thorneycroft; Field. Marine and Locomotive Boilers.

TOOLMAKERS' COURSE

A thorough, practical course prepared for Toolmakers, Machinists, and Steel Workers.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Metallurgy.
Forging.
Machine Shop Work Part I.
Machine Shop Work Part II.
Machine Shop Work Part III.
Toolmaking Part I.
Toolmaking Part II.
Toolmaking Part III.
*Mechanical Drawing Part I.
*Mechanical Drawing Part II.
*Mechanical Drawing Part III.
*Mechanical Drawing Part IV.
*Mechanical Drawing Part V.
*Mechanical Drawing Part VI.

*Optional.

Tuition $25.00. Payable Monthly.

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SYNOPSIS OF COURSE

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract: Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

ARITHMETIC PART II

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator: Addition, Subtraction, Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

ARITHMETIC PART III

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight; Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers: Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent: Consequent: Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction;. Multiplication; Division. Cancellation: Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons. Circles. Volumes and Surfaces of Prisms. Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

METALLURGY

IRON AND STEEL: Ores: Magnetite; Hematite; Limonite; Siderite. Minerals: Iron Pyrites; Franklinite. Preparation of Ores.

BLAST FURNACE: Ores; Flux; Fuel; Slag. Operation and Chemistry of Furnace. Cast Iron: Grades and Impurities. Malleable Cast Iron.

WROUGHT IRON: Direct Process; Puddling Process; Operation of Furnace. Welding.

STEEL: Blister Steel; Crucible Steel; Bessemer Process: Converter; Acid and Basic Bessemer; Cupola Process; Molds and Molding. Rails. Open Hearth Process: Martin Process; Siemens Process; Combination; Gas Producers. Special Steels; Casehardening; Effects of Elements in Steel; Tempering: Colors and Temperature.

OTHER METALS: Copper: Ores; Extraction; Smelting; Refining. Lead: Smelting; Softening and Desilverizing; Refining. Tin. Zinc. Aluminum. Tables of Properties of Metals and Alloys.

SHOP PRACTICE

FORGING: Wrought Iron; Steel. The Forge: Tuyeres; Fuel; Blast. Tools: Hammer; Anvil; Tongs; Chisels; Flatter; Swages; Punches; etc. Forging and Finishing: Staples; Bolts; Hooks; Tongs; Wrenches; etc. Tool Dressing. Welding and Tempering: Temperature; Scale; Flux; Scarfing; Butt and Lap Welding; Welding Steel to Wrought Iron. Annealing; Case Hardening; Brazing. Power Tools: Hammers; Punches; Shears; Drop Forges; Bolt Headers; Presses. Forging Shafts, Connecting Rods; Cranks; etc. Shop Suggestions: Shrinkage; Expansion.

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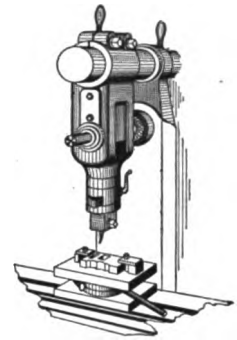
MACHINE SHOP WORK: Hand Tools; Hammer; Center Punch; Surface Gauge; Scales; Calipers; Micrometer; Vernier Micrometer; Gauges; Chisels; Files and Filing; Drills; Reamers; Taps and Dies. Lathes and Tools; Chucks; Dogs; Mandrels; Centering; Turning Tools; Turning; Tool Posts; Boring Tools; Cutting Speed; Grinding; Turning a Taper; Taper Attachment; Eccentric Turning. Boring. Boring Bars. Screw Cutting; Tools; Lead Screw; Gears: Compound Lathe; Chasing. Drilling in Lathe; Chucks. Drill Press; Drilling; Holding Work. Planer: Tools; Holding Work. Plate Planer. Shaper and Slotter. Milling Machine. Mills; Speed of Mills; Tables; Interchangeable Work. Grinding; Laying out Work; Shop Suggestions; Surface Plate; Drilling Hard Metals; Fitting Brasses; Fluting Rollers; Pickling; Lining up Shafting.



TOOL MAKING: Measuring Instruments; Annealing, Hardening, and Grinding Twist Drills. Reamers: Kinds; Cutting Edges; Straightening; Grinding; Adjustable Reamers; Reamer Holders. Expanding Mandrels; Eccentric Arbors; Milling Machine Arbors. Taps: Flutes; Hardening; Screw Die Hobs; Releasing Tap Holders. Screw Cutting Dies: Cutting Edges; Clearance; Spring Screw Threading Dies. Die Holders. Counterbores: Facing Tool with Inserted Cutter; Inserted Pilots; Combination Counterbores. Hollow Mills. Forming Tools; Holders. Milling Cutters: Teeth; Hardening and Grinding Hole to Size; Interlocking, Nicked and Inserted Teeth; End Mills; Spiral Mills; T-slot Cutters; Drill Jigs; Slab Jigs; Bushings; Legs; Leaf; Box Jigs. Punch and Die Work: Guide; Stripper; Gauge Pin; Shear. The Punch: Laying Out; Shear; Locating Pins; Bending Dies; Forming Dies. Gauges: Accuracy; Grinding; Lapping.

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

SHEET METAL WORK

A short, practical course for Sheet-Metal Workers, Tinsmiths, Plumbers, Carpenters, Contractors and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
*Heat.
*Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Sheet Metal Work Part I.
Sheet Metal Work Part II.

*Optional.

Tuition $25.00. Payable Monthly.

SYNOPSIS OF COURSE

MATHEMATICS

ARITHMETIC: Units; Numbers; Notation; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation; Fractions; Decimals; Symbols of Aggregation; Percentage; Denominate Numbers; Tables of Linear and Square Measure; Tables of Weights; Involution; Evolution; Square Root; Cube Root; Roots of Fractions; Ratio; Proportion.

ELEMENTARY ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division; Cancellation; Equations; Transportation; Finding Value of Unknown Quantities.

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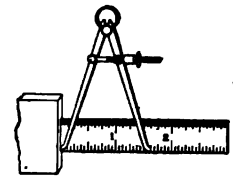
MENSURATION: Lines; Angles; Polygons; Circles; Sectors and Segments. Measurement of Angles; Triangles; Rectangles; Trapezoids; Hexagons; Circles; Volumes and Surfaces of Prisms; Cylinders; Pyramids; Cones; Frustums; Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

HEAT



DEFINITION AND NOTATION: Definition of Heat; Amount of Heat; Degree of Heat; Thermometer; Temperature; Fahrenheit; Centigrade; Reaumur. Freezing and Boiling Points. Notation: Absolute Temperature; Changing from one Scale to another.

HEAT EFFECTS: Expansion: Cubical; Linear; Coefficients of Expansion; Expansion of Solids, Liquids and Gases. Liquefaction: Laws of Fusion; Table of Melting Points; Vaporization; Evaporation; Boiling; Table of Boiling Points; Boiling under Pressure and in Vacuum. Distillation; Conduction; Convection; Radiation.

THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

PRACTICAL APPLICATIONS: The Steam Engine and Hot-Air Engine; Manufacture of Ice; Production of Liquid Air.

METALLURGY

IRON AND STEEL: Ores: Magnetite; Hematite; Limonite; Siderite. Minerals: Iron Pyrites; Franklinite. Preparation of Ores.

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WROUGHT IRON: Direct Process; Puddling Process; Operation of Furnace. Welding.

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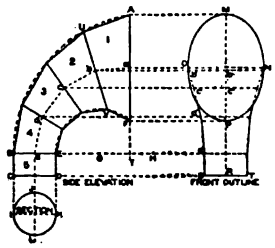
OTHER METALS: Copper: Ores; Extraction; Smelting; Refining. Lead: Smelting; Softening and Desilverizing; Refining. Tin. Zinc. Aluminum. Tables of Properties of Metals and Alloys.

MECHANICAL DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises in Line Work.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.



PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric; Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projections of Crank Arm.

LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

SHEET METAL WORK

CONSTRUCTION: Tables; Shop Tools; Methods of Obtaining Patterns.

INTERSECTION AND DEVELOPMENTS: Prisms and Cylinders; Quadrangular Prism and Sphere. Development by Triangulation; Scalene Cone; Irregular Solids. Approximate Developments. Circular Molds.

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PRACTICAL SHOP PROBLEMS: Bathtub, Hip Bath, Funnel Strainer, Pail, Sink Drainer, Ventilator, Elbows in Round, Square and Oval Pipes, Tapering Elbows in Round and Square Pipes, Tapering Elbow Round to Oval, Rain-Water Cut-off, Transition Piece in Rectangular Pipe, Curved Rectangular Chute, Hopper Register Box, Transition Piece from Round Base to Round Top placed Vertically, Offset Round to Oval, Three-way Branch Round to Round, Two-Branch Fork Oval to Round, Tapering Flange Around Pipe Passing through an Inclined Roof, Round Pipe Intersecting Conical Furnace Top; to One Side of Center of Top, Sphere, Ogee Basin, Brewer's Kettle, Moulded Cap on Stack, Elbows in Heavy Metal, Intersecting Pipes in Boiler Work, Gusset Sheet on Boiler, Scroll Signs in Heavy Metal.

METAL ROOFING

A concise course prepared for Metal Roofers, Plumbers, Tinsmiths and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
*Heat.
*Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Metal Roofing.

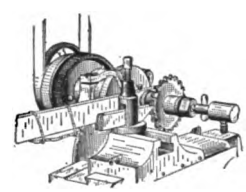
*Optional.

Tuition $25.00. Payable Monthly.

SYNOPSIS OF COURSE

MATHEMATICS

ARITHMETIC: Units; Numbers; Notation; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation; Fractions; Decimals; Symbols of Aggregation; Percentage; Denominate Numbers; Tables of Linear and Square Measure; Tables of Weights; Involution; Evolution; Square Root; Cube Root; Roots of Fractions; Ratio; Proportion.



ELEMENTARY ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division; Cancellation; Equations; Transportation; Finding Value of Unknown Quantities.

MENSURATION: Lines; Angles; Polygons; Circles; Sectors and Segments. Measurement of Angles; Triangles; Rectangles; Trapezoids; Hexagons; Circles; Volumes and Surfaces of Prisms; Cylinders; Pyramids; Cones; Frustums; Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

HEAT

DEFINITION AND NOTATION: Definition of Heat; Amount of Heat; Degree of Heat; Thermometer: Temperature; Fahrenheit; Centigrade; Reaumur. Freezing and Boiling Points. Notation: Absolute Temperature; Changing from one Scale to another.

HEAT EFFECTS: Expansion: Cubical; Linear; Coefficients of Expansion; Expansion of Solids, Liquids and Gases. Liquefaction: Laws of Fusion; Table of Melting Points; Vaporization; Evaporation; Boiling; Table of Boiling Points; Boiling under Pressure and in Vacuum. Distillation; Conduction; Convection; Radiation.

THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

PRACTICAL APPLICATIONS: The Steam Engine and Hot-Air Engine; Manufacture of Ice; Production of Liquid Air.

METALLURGY

IRON AND STEEL: Ores: Magnetite; Hematite; Limonite; Siderite. Minerals: Iron Pyrites; Franklinite. Preparation of Ores.

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BLAST FURNACE: Ores; Flux; Fuel; Slag. Operation and Chemistry of Furnace. Cast Iron: Grades and Impurities. Malleable Cast Iron.

WROUGHT IRON: Direct Process; Puddling Process; Operation of Furnace. Welding.

STEEL: Blister Steel; Crucible Steel; Bessemer Process: Converter; Acid and Basic Bessemer; Cupola Process; Molds and Molding. Rails. Open Hearth Process: Martin Process; Siemens Process; Combination; Gas Producers. Special Steels; Casehardening; Effects of Elements in Steel; Tempering: Colors and Temperature.

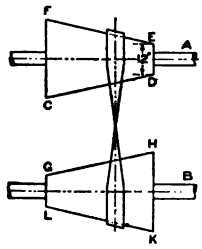
OTHER METALS: Copper: Ores; Extraction; Smelting; Refining. Lead: Smelting; Softening, and Desilverizing; Refining. Tin. Zinc. Aluminum. Tables of Properties of Metals and Alloys.

MECHANICAL DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates: Exercises in Line Work.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections. Shade Lines: Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.



LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters: Titles for Drawings. Plates.

METAL ROOFING

SHEET METAL SKYLIGHT WORK: Methods of Construction; Tables; Shop Tools; Making Patterns; Various Shapes of Bars and Curbs; Styles of Skylights; Pitch; Hipped, Turrets, Conservatory, Photographic, Extension, Louvred, Terraced, Gearings, Development of Patterns; Ventilator, Curb, Hip Bar, Jack Bar, Common Bar, Cross-bar, Turret Sash, Length of Bars for Skylights.

METAL ROOFING: Coverings; Tables; Tools; Roof Mensuration: Flat Roof; Irregular-shaped Roof; Hipped Roof; Flat Seam Roofing: Preparing Sheets, Laying, Base Flashings; Cap Flashings, Expansion and Contraction, Fastening Metal to Stone, Solder, Conical Tower, Electrical Action; Roof Flashing for Soil Pipes; Standing Seam Roofing; Locking Sheets, Preparing Roll, Bending, Cleats, Seaming, Finishing Eaves and Ridge; Counter Flashing; Corrugated Iron Roofing and Siding; Sizes and Corrugations; Tables; Fastening to Wood and Iron; Laying a Valley; Flashing Around Chimneys and Smokestack; End-Wall Flashings; Ridge Rolls, Covering Sidings and Awnings; Flat Casings.

CORNICE WORK

A short, practical course prepared for Steet-Metal Workers, Tinsmiths, Roofers, Architects, Contractors and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
*Heat.
*Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Cornice Work.

*Optional.

Tuition $25.00. Payable Monthly.

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SYNOPSIS OF COURSE

MATHEMATICS

ARITHMETIC: Units; Numbers; Notation; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation; Fractions; Decimals; Symbols of Aggregation; Percentage; Denominate Numbers; Tables of Linear and Square Measure; Tables of Weights; Involution; Evolution; Square Root; Cube Root; Roots of Fractions; Ratio; Proportion.

ELEMENTARY ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division; Cancellation; Equations; Transportation; Finding Value of Unknown Quantities.

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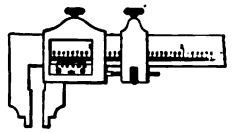
MECHANICAL DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates: Exercises in Line Work.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterials; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.



LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

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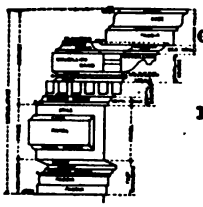
SHEET METAL CORNICE WORK

CONSTRUCTION: Tools; Methods for Obtaining Patterns; Moldings; Miters; Horizontal Moldings on Plane and Curved Surfaces; Panel Miters; Miters between Moldings of Different Profiles. Curved Moldings; Molding Intersecting Pilaster.



GABLE MOLDING: Square Turret; Horizontal Returns at Top and Foot of Segmental Pediment; Gable Moldings; Raking Bracket; Gutter Miters; Star; Hip Ridge Miter; Eyebrow Dormer; Bay Window.

DEVELOPMENTS OF BLANKS FOR CURVED MOLDINGS: Tools; Approximate Blanks for Curved Moldings Hammered by Hand. Plain Flare; Cove Mold; Ogee Mold; Bead; Bottom of Circular Bay. Approximate Blanks for Curved Moldings Hammered by Machine. Moldings Curved in Elevation and in Plan; Blank for Bull's-eye Window.

TINSMITHING

A short, practical course prepared for Tinsmiths, Sheet-Metal Workers, Plumbers and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
*Heat.
*Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Tinsmithing.

*Optional.

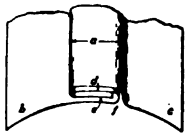
Tuition $25.00. Payable Monthly.

SYNOPSIS OF COURSE

MATHEMATICS

ARITHMETIC: Units; Numbers; Notation; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation; Fractions; Decimals; Symbols of Aggregation; Percentage; Denominate Numbers; Tables of Linear and Square Measure; Tables of Weights; Involution; Evolution; Square Root; Cube Root; Roots of Fractions; Ratio; Proportion.

ELEMENTARY ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division; Cancellation; Equations; Transportation; Finding Value of Unknown Quantities.



MENSURATION: Lines; Angles; Polygons; Circles; Sectors and Segments. Measurement of Angles; Triangles; Rectangles; Trapezoids; Hexagons; Circles; Volumes and Surfaces of Prisms; Cylinders; Pyramids; Cones; Frustums; Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

HEAT

DEFINITION AND NOTATION: Definition of Heat; Amount of Heat; Degree of Heat; Thermometer: Temperature; Fahrenheit; Centigrade; Reaumur. Freezing and Boiling Points. Notation: Absolute Temperature; Changing from one Scale to another.

HEAT EFFECTS: Expansion: Cubical; Linear; Coefficients of Expansion; Expansion of Solids, Liquids and Gases. Liquefaction: Laws of Fusion; Table of Melting Points; Vaporization; Evaporation; Boiling; Table of Boiling Points; Boiling under Pressure and in Vacuum. Distillation; Conduction; Convection; Radiation.

THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

PRACTICAL APPLICATIONS: The Steam Engine and Hot-Air Engine; Manufacture of Ice; Production of Liquid Air.

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METALLURGY

IRON AND STEEL: Ores: Magnetite; Hematite; Limonite; Siderite. Minerals: Iron Pyrites; Franklinite. Preparation of Ores.

BLAST FURNACE: Ores; Flux; Fuel; Slag. Operation and Chemistry of Furnace. Cast Iron: Grades and Impurities. Malleable Cast Iron.

WROUGHT IRON: Direct Process; Puddling Process; Operation of Furnace. Welding.

STEEL: Blister Steel; Crucible Steel; Bessemer Process: Converter; Acid and Basic Bessemer; Cupola Process; Molds and Molding. Rails. Open Hearth Process: Martin Process; Siemens Process; Combination; Gas Producers. Special Steels; Casehardening; Effects of Elements in Steel; Tempering: Colors and Temperature.

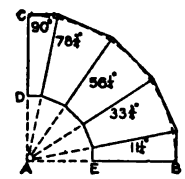
OTHER METALS: Copper: Ores; Extraction; Smelting; Refining. Lead: Smelting; Softening and Desilverizing; Refining. Tin. Zinc. Aluminum. Tables of Properties of Metals and Alloys.

MECHANICAL DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates: Exercises in Line Work.

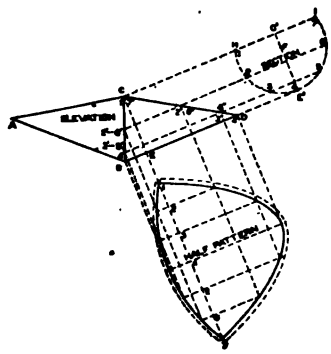
GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterials; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-eight Problems in Geometrical Drawing.

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection: True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections. Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.



LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

TINSMITHING



PRINCIPLES AND METHODS OF CONSTRUCTION: Tables of Standard Tin Plate; Capacity of Vessels; Methods of Obtaining Patterns. Joints.

INTERSECTIONS AND DEVELOPMENTS: Plan; Elevation; Stretchout Line; Measuring Lines. Prisms; Cylinders; Frustums; Truncated Prisms; Cones; Pyramids. Intersections and Developments of Cones and Cylinders of Unequal Diameters and whose Axes form an Angle of 45 Degrees. Short Rules for Practical Problems. Allowance for Seaming and Wiring. Notching and Transferring Patterns.

PRACTICAL TINWARE PROBLEMS: Development of Patterns for Pail; Funnel and Spout; Hand Scoop; Drip Pan; Tea Pot; Foot Bath; Wash Boiler; Quart Measure; Scale Scoop; Dust Pan; Colander.

EXAMINATION PLATES: Intersections and Developments; Practical Problem.

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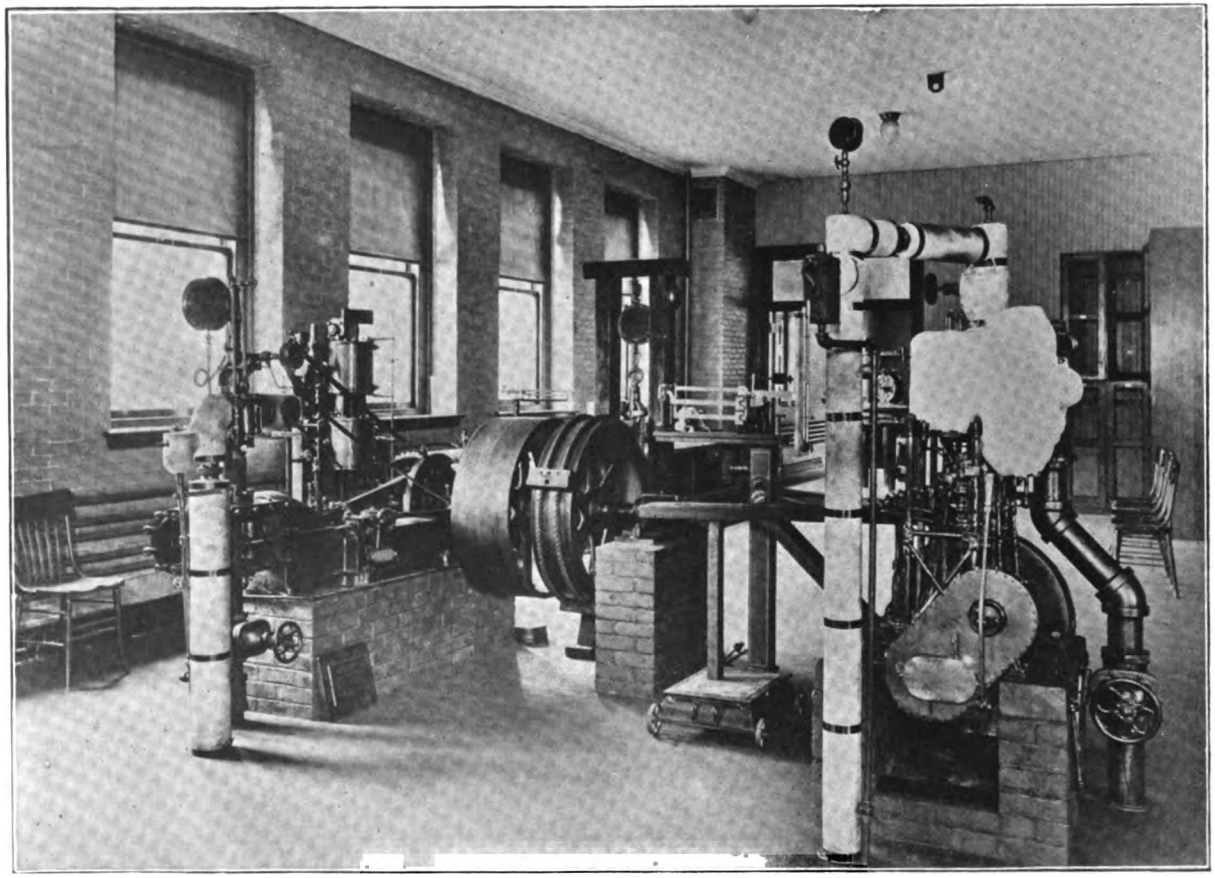

Steam Engine Laboratory, Harvard University

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DEPARTMENT OF

STEAM ENGINEERING

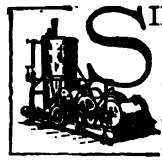
Partial list of the well-known authorities and educators who personally have prepared the instruction papers for correspondence study.

ARTHUR L. RICE, M. M. E.,
Editor, "The Engineer."
WALTER B. SNOW, S. B.,
B. F. Sturtevant Company.
FRANCIS H. BOYER,
Consulting Refrigerating Engineer.
CHARLES L. GRIFFIN, S. B.,
Semet-Solvay Company.
GEORGE L. FOWLER, A. B. M. E.,
Consulting Mechanical Engineer.
WALTER S. LELAND, S. B.,
Mass. Institute of Technology.
CHARLES L. HUBBARD, S. B., M. E.,
S. Homer Woodbridge Co.
WALTER H. JAMES, S. B.,
Mass. Institute of Technology.
CHARLES DICKERMAN,
Refrigerating Engineer,
LIONEL S. MARKS, S. B., M. M. E.,
Harvard University.

COURSES

STATIONARY ENGINEERING
MARINE ENGINEERING
LOCOMOTIVE ENGINEERING
BOILERS AND ENGINES
SPECIAL MARINE
SPECIAL LOCOMOTIVE
SPECIAL REFRIGERATION
ENGINEERS' COURSE
FIREMEN'S COURSE

STEAM ENGINEERING



SINCE the days of Watt and Stephenson, engineers have sought to make the steam engine a more perfect machine. Greater care in design, construction and operation has transformed the huge, wasteful, slowspeed engine of early times into the light, smooth-running machine of to-day. Carefully directed study and skill in design have greatly reduced the weight per horse power and increased the piston speed to a point formerly considered impossible.

On account of the natural division of Steam Engineering, the instruction has been prepared for Stationary Engineers, Marine Engineers, and Locomotive Engineers. These courses enable the Stationary Engineer to become familiar with the machinery found in steam plants ashore without taking up the peculiarities of marine and locomotive work. They assist the Marine or Locomotive Engineer in getting just the information he needs.

The growing importance of mechanical refrigeration demands in-

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struction in this subject for the Stationary and Marine Engineer. Heating and ventilation also require attention on the part of the Stationary Engineer having in his charge the heating system in addition to the machinery for power. Although the instruction in electrical subjects is not as complete as in the Electrical Engineering Course, it is a great aid to the Steam Engineer in the successful operation of electrical machinery.

STATIONARY ENGINEERING COURSE

Prepared for Stationary Engineers, Firemen, Oilers, Builders of Boilers and Engines, Inspectors, Steam Fitters, Designers, Draftsmen, Electricians, Superintendents, Managers and Chief Engineers of Power Stations and Manufacturing Plants, Mechanical Engineers, Consulting Engineers, Contractors, Instructors, Students and others interested in Steam Engineering.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
*Machine Design Part I.
*Machine Design Part II.
Steam Pumps.
Steam Engine Part I.
Valve Gears.
Indicators.
Steam Engine Part II.
Gas Producers.
Gas and Oil Engines.
Refrigeration Part I.
Refrigeration Part II.
Heating and Ventilation Part I.
Heating and Ventilation Part II.
Heating and Ventilation Part III.
Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Types of Dynamo-Electric Machinery.
Management of Dynamo-Electric Machinery Part I.
Management of Dynamo-Electric Machinery Part II.
Electric Wiring.
Electric Lighting.
Elevators.
*Algebra Part I.
*Algebra Part II.
*Geometry.
*Trigonometry and Logarithms.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.

*Optional.

Tuition $50.00. Payable Monthly.

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SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 166

STEAM BOILERS

CONSTRUCTION OF BOILERS: Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; Horse Power; General Requirements; Grate Area; Draft; Tubes; Steam and Water Spaces; Heating Surface; Water Level; Strength of Boiler Shell; Formulas for Thickness and Allowable Pressure; Equations and Formulas for Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Uptake; Chimney.

TYPES OF BOILERS: Cornish; Lancashire; Galloway; multitubular; Vertical Boilers; Manning; Cochrane; Fire Engine; etc. Water Tube Boilers: Babcock & Wilcox; Root; Heine; Almy; Cahill; Belleville; Yarrow; Thornycroft; Field. Return and Through Tube Marine Boilers; Locomotive Boilers.

BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps: Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Calorimeters; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels: Coal; Coke; Wood; Petroleum; Composition and Heat Value of Fuels. Care of Boilers: Fittings; Feed Water; Firing; Cleaning; Inspection; Testing.

STEAM ENGINES

PUMPS: Principles of Action; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves: Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank Crosshead; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping Accessories: Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine; De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Watts Indicator; Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power. Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption from Indicator Card.

VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagrams; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy Valve Gears. Other Valves: Piston; Double Ported; Trick; Corliss. Methods of Balancing Valves.

ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter Brake; Log of Test.

STEAM TURBINE: Steam Consumption, etc.

GAS PRODUCERS

GAS PRODUCERS: Introduction; Analysis; Gaseous Fuels; Manufacture; Operation; Fuel; Losses; Heat Balance; Classification; Types; Induced Draft Gas Producer; Suction Gas Producer; Bi-Product Gas Producer; Gas Cleaning; Uses; Gas Producer Power Plants; Steam Boilers; Ceramic Kilns; Metallurgical Furnaces; Conclusion.

GAS AND OIL ENGINES

GAS AND OIL ENGINES: External Combustion Motor; Internal Combustion Motor; Lenoir Gas Engine; Otto Cycle; Construction; Explosive Mixture; Operation; Exhaust; Valves; Pressures and Temperatures; Adiabatic Expansion; Work Done; Hot Tube Ignition; Jump Spark; Wipe Spark; Governing; Starting; Water Jacket; Coal Gas; Water Gas; Producer Gas; Fuel Consumption; Oil Engine; Gasoline Engine; Crude Oil Engine; Diesel Cycle.

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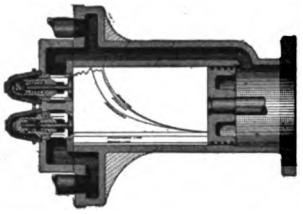
MACHINE DESIGN

SEE SYNOPSIS PAGE 49

REFRIGERATION

REFRIGERATION: Unit of Refrigeration; Thermometers; Theory; Systems; Definitions. Ammonia; Carbonic Acid; Air; Tables. Compression and Absorption Systems; Brine Tanks; Compressors: Types; Methods of Cooling; Details. Condensers; Types; Means of Distributing Water. Oil Separator; Ammonia Storage Tanks; Pressure Gages; Brine; Chloride of Calcium; Salt; Tables of Weights, Specific Heat and Freezing Point. Management of Refrigerating Machinery.



ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.

ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Types of Fields; Series, Shunt and Compound Windings.

DIRECT CURRENT DYNAMOS: Constant Current; Constant Potential; Series, Shunt and Compound Dynamos: Characteristic Curves; External; Internal; Total. Long and Short Shunt. Magneto-motive Force; Magnetic Reluctance; Magnetising Force. Field Magnets. Dynamo Construction: Armature Core and Windings; Binding Wires; Closed and Open Coil Armature Commutators; Brushes; Brush Holders; Field Magnets and Coils. Sparking. Installation. Operation. Testing.

DIRECT CURRENT MOTORS: Principles; Equations: Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Series Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

TYPES OF DYNAMO-ELECTRIC MACHINERY. DIRECT CURRENT. Classes; Methods of Driving; Types: General Electric; Crocker-Wheeler; Westinghouse; Bullock; C and C; Holtzer-Cabot, etc.; Electrolytic Work; Arc Lighting Generators; Railway Motors; Motor-Generators and Dyna-motors.

ELECTRIC LIGHTING: Lamps; Candle Power; Incandescent Lamps; Arc Lights; Systems of Distribution, Feeders; Potential; Location of Lamps; Power required; Location and Equipment of Plant; Overhead and Underground Systems; Wiring of Buildings; Size of Wire; Calculations.

HEATING AND VENTILATION

HEATING AND VENTILATION: Systems of Warming; Hot Air; Hot Water; Steam; Electricity. Principles of Ventilation. Heat loss from Buildings; Calculations and Tables. Furnace Heating: Registers; Care; Steam Boilers and Hot Water Heaters. Steam Heating: Direct and Indirect Systems; Radiators; Valves; Wet and Dry Returns; Hot Water Heating: Direct and Indirect; Expansion Tank. Exhaust Heating and Ventilation; Blowers.

ELEVATORS

ELEVATORS: Steam Elevators; Water Balance Elevators; Horizontal Hydraulic Elevators; Vertical Hydraulic Elevators; Packing and Lubrication; Limit Valves; Electric Elevators; Controllers; Electric Limit Switches; Elevator Accessories; Cables; Air Cushions.

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

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MARINE ENGINEERING COURSE

INCLUDING MECHANICAL DRAWING

Prepared for Marine Engineers, Chief Engineers and Assistants, Inspectors of Boilers and Engines, Superintendents of Shipyards, Consulting Engineers, Firemen, Stokers, Oilers, Owners of Launches, Engine Builders, Boilermakers, Ship Builders, Dealers in Marine Machinery and Supplies, Steamboat Officers, Inventors, Designers, Draftsmen, Salesmen, Instructors and Engineering Students.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Marine Boilers.
Machine Design Part I.
Machine Design Part II.
Steam Pumps.
Steam Engine Part I.
Indicators.
Valve Gears.
Steam Engine Part II.
Marine Engines.
Gas Producers.
Gas Engines.
Refrigeration Part I.
Refrigeration Part II.
Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Electric Wiring.
*Electric Lighting.
*Algebra Part I.
*Algebra Part II.
*Geometry.
*Trigonometry and Logarithms.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.
*Advanced Machine Design Part I.
*Advanced Machine Design Part II.

*Optional.

Tuition $50.00. Payable Monthly.

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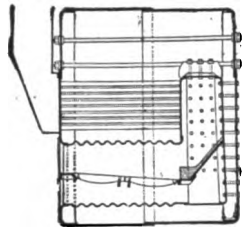
SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 166

STEAM BOILERS

CONSTRUCTION OF BOILERS: Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; General Requirements; Grate Area; Draft; Tubes; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Formulas for Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Uptake; Chimney.



TYPES OF BOILERS: Cornish; Lancashire; Galloway; Multitubular; Vertical; Manning; Cochrane; Fire Engine; Water-Tube Boilers; Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Yarrow; Thorneycroft; Field. Marine Boilers; Locomotive Boilers.

BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Calorimeters; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels; Composition and Heat Value of Fuels. Care of Boilers: Fittings; Feed Water; Firing; Cleaning; Inspection; Testing.

MARINE BOILERS: Cylindrical; Water Tube; Gunboat Boilers. Construction: Materials; Testing; Shell; Riveting; Flanging; Furnaces; Tubes and Stays. Dimensions: Grate; Heating Surface; Size of Boiler. Details: Valves; Gages; Pumps; Salinometer; Hydrokimeter; Lagging. Draft: Closed Ash-pit; Closed Stokehole; Kafers Method; Induced Systems. Mechanical Stokers; Fuels. Getting up Steam; Stoking; Cleaning and Banking; Repairs. Types and Advantages of Water-tube Boilers. Launch Boilers.

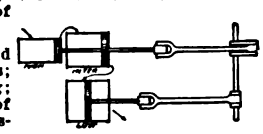
STEAM ENGINES

PUMPS: Principles of Action; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves; Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank; Crosshead; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping. Accessories: Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine: De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Watts Indicator; Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power; Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption from Indicator Card.

VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagrams; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy valve Gears. Other Valves: Piston; Double Ported; Trick; Corliss. Methods of Balancing Valves.



ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter Brake; Log of Test.

STEAM TURBINE: Steam Consumption, etc.

MARINE ENGINES: Propulsion; Types of Marine Engines; Nautical Terms; Details of Engines; Starting Gear; Condensers; Air Pump; Circulating Pump; Auxiliary Machinery. Propellers: Material; Shape; Pitch; Slip; Negative Slip; Twin and Triple Screws. Fittings: Valves and Cocks; Water Service. Management: Lubrication; Hot Bearings; Linking Up; Stopping. Emergencies: Broken Cylinder Head, Crank Shaft and Piston. Breaking of Eccentric; Breaking Down of Air Pump; etc.

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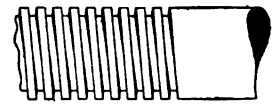
MACHINE DESIGN

DEFINITION AND RELATION: Theoretical and Commercial Considerations; Invention; Original Design; Handbooks; General Reference Books; Empirical Data; Calculations; Notes; Records.



CONSTRUCTIVE MECHANICS AND DESIGN: Forces; Moments; Beams. Tension; Compression; Torsion. Friction and Lubrication. Working Stresses; Strains. Analysis of Conditions and Forces; Theoretical Construction; Practical Modification; Delineation and Specification.

APPLICATION TO POWER TRANSMISSION: Speed Ratio; Power; Load; Efficiency; Preliminary Calculation; Layout; Design of Parts; Belts; Pulleys; Shafts; Gears. Couplings; Clutches; Brakes. Bearings; Brackets; Stands; Bolts; Nuts; Screws; Keys; Pins; Cotters.

SIMPLE MACHINE ELEMENTS: Types; Materials; Shop Machinery; Processes; Construction; Cost; Competition; Machinery Market. Working Detail Drawings of Parts in a Practical Case of Power Transmission.

REFRIGERATION

REFRIGERATION: Unit of Refrigeration; Thermometers; Theory; Systems; Definitions. Ammonia; Carbonic Acid; Air; Tables. Compression and Absorption Systems; Brine Tanks; Compressors; Types; Methods of Cooling; Details. Condensers; Types; Means of Distributing Water. Oil Separator; Ammonia Storage Tanks; Pressure Gages; Brine; Chloride of Calcium; Salt; Tables of Weights, Specific Heat and Freezing Point. Management of Refrigerating Machinery.

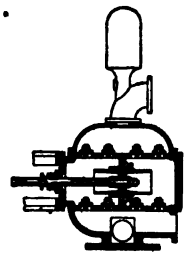
ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.

ELECTRIC CURRENT: Resistance: Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Types of Fields; Series, Shunt and Compound Windings.

DIRECT CURRENT DYNAMOS: Constant Current; Constant Potential; Series, Shunt and Compound Dynamos; Characteristic Curves; External; Internal; Total. Long and Short Shunt. Magneto-motive Force; Magnetic Reluctance; Magnetizing Force. Field Magnets. Dynamo Construction: Armature; Armature Core and Windings; Binding Wires; Closed and Open Coil Armature Commutators; Brushes; Brush Holders; Field Magnets and Coils. Sparking. Installation. Operation. Testing.



DIRECT CURRENT MOTORS: Principles; Equations; Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Series Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

ELECTRIC WIRING: Wires; Coverings; Joints; Wiring Fixtures: Cleats; Casings; Tunnels; Batteries; Grouping of Cells; Annunciators; Bells; Buzzers; Switches; Plugs; Sockets; Fuses; Meters; Applications; Plans and Specifications; Fire Risks; Insurance Rules and Regulations; Inspectors.

ELECTRIC LIGHTING: Lamps: Candle Power; Incandescent Lamps; Arc Lights; Systems of Distribution, Feeders; Potential; Location of Lamps; Power required; Location and Equipment of Plant; Overhead and Underground Systems; Wiring of Buildings; Size of Wire; Calculations.

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

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LOCOMOTIVE ENGINEERING COURSE

INCLUDING MECHANICAL DRAWING

Prepared for Locomotive Engineers and Firemen, Switchmen, Brakemen, Towermen, Flagmen, Section Hands, Signalmen, instructors, Students, Inspectors, Master Mechanics and others interested in Railroading.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Machine Design Part I.
Machine Design Part II.
Steam Engine Part I.
Indicators.
Valve Gears.
Steam Engine Part II.
The Air Brake.
Locomotive Boilers and Engines Part I.
Locomotive Boilers and Engines Part II.
Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Types of Dynamo-Electric Machinery.
*Electric Lighting.
*Electric Railways Part I.
*Electric Railways Part II.
*Algebra Part I.
*Algebra Part II.
*Geometry.
*Trigonometry and Logarithms.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.
*Advanced Machine Design Part I.
*Advanced Machine Design Part II.

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*Optional.

Tuition $50.00. Payable Monthly.

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SYNOPSIS OF COURSE

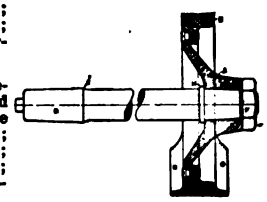
GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY } SEE SYNOPSIS PAGE 166

STEAM BOILERS

CONSTRUCTION OF BOILERS: Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; General Requirements; Grate Area; Draft; Tubes; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Formulas for Riveted Joints: Flues, Tubes and Stays; Manholes; Brackets; Chimney.

TYPES OF BOILERS: Multitubular; Vertical; Manning; Fire Engine; Water-Tube Boilers; Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Yarrow; Thorneycroft; Field. Marine Boilers; Locomotive Boilers.



BOILER ACCESSORIES: Furnaces; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels; Composition and Heat Value of Fuels. Care of Boilers.

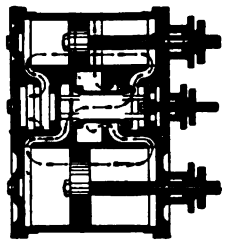
STEAM ENGINES

PUMPS: Principles of Action; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves; Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank; Crosshead; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping. Accessories; Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine: De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power; Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption from Indicator Card.

VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagrams; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy valve Gears. Other Valves: Piston; Double Ported; Trick; Corliss. Methods of Balancing Valves.



ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter Brake; Log of Test.

STEAM TURBINE: Steam Consumption, etc.

LOCOMOTIVE BOILERS: Belpaire; Wootten; Lentz; Details; Materials; Firebox; Stays; Water Table; Grate; Ash Pan; Dampers; Fuels; Rate of Combustion; Smoke Box; Exhaust Nozzle; Petticoat Pipe; Stack; Boiler Fittings: Valves; Whistle; Gages; Blower; Injectors.

LOCOMOTIVE ENGINES: Piston; Crosshead; Connecting Rod; Parallel Rods; Valve Motion; Reversing Gear; Setting Valves; Running Gear; Counterbalancing. Types: Eight Wheeled; Forney; Columbia; Atlantic; Mogul; Consolidation; Decapod. Compound Locomotives. Signals: Targets; Semaphores; Block Signals; Train Signals; Flags. Running: Firing; Fuels; Use of Steam; Cut Off; Learning the Road; Grades; Handling Trains; Inspection; Repairs; Emergencies; Train Rules; Time Tables. Specifications for Engine and Tender.

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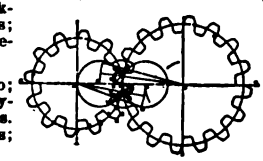
MACHINE DESIGN

DEFINITION AND RELATION: Theoretical and Commercial Considerations; Invention; Original Design; Handbooks; General Reference Books; Empirical Data; Calculations; Notes; Records.

CONSTRUCTIVE MECHANICS AND DESIGN: Forces; Moments; Beams. Tension; Compression; Torsion. Friction and Lubrication. Working Stresses; Strains. Analysis of Conditions and Forces; Theoretical Construction; Practical Modification; Delineation and Specification.



APPLICATION TO POWER TRANSMISSION: Speed Ratio; Power; Load; Efficiency; Preliminary Calculation; Layout: Design of Parts; Belts; Pulleys; Shafts; Gears. Couplings; Clutches; Brakes. Bearings; Brackets; Stands; Bolts; Nuts; Screws; Keys; Pins; Cotters.

SIMPLE MACHINE ELEMENTS: Types; Materials; Shop Machinery; Processes; Construction; Cost; Competition; Machinery Market. Working Detail Drawings of Parts in a Practical Case of Power Transmission.

AIR BRAKE

RAILWAY BRAKES: Hand; Vacuum; Compressed Air; Straight-Air Brake; Automatic Brake. Westinghouse and New York Air Brakes. Details.

AUTOMATIC BRAKE: Parts: Pump; Governor; Engineer's Valve; Reservoir; Gages; The Triple Valve; Brake Cylinders; Air Pump: Description; Operation; Brake Rigging; Plan of Car; Brake Shoe Pressure; Driving-Wheel Brakes; High-Speed Brake: Detail Parts.

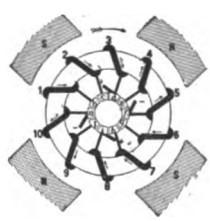
HANDLING AIR BRAKES AND SIGNALS: Service and Emergency Application; Cutting out Brakes; Defects and Accidents; General Instructions; Systems of Air Signals.

ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.

ELECTRIC CURRENT: Resistance: Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Types of Fields; Series, Shunt and Compound Windings.



DIRECT CURRENT DYNAMOS: Constant Current; Constant Potential; Series, Shunt and Compound Dynamos; Characteristic Curves: External; Internal; Total. Long and Short Shunt. Magneto-motive Force; Magnetic Reluctance; Magnetizing Force. Field Magnets. Dynamo Construction: Armature; Armature Core and Windings; Binding Wires; Closed and Open Coil Armature Commutators; Brush Holders; Field Magnets and Coils. Sparking. Installation. Operation. Testing.

DIRECT CURRENT MOTORS: Principles; Equations; Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

ELECTRIC LIGHTING: Lamps; Candle Power; Incandescent Lamps; Arc Lights; Systems of Distribution. Feeders; Potential; Location of Lamps; Power required; Location and Equipment of Plant; Overhead and Underground Systems; Wiring of Buildings; Size of Wire; Calculations.

ELECTRIC RAILWAYS: Car Equipment; Motors; Controllers; Trolley; Car Wiring; Line Construction; Feeders; Bonding; Electrolysis. Power Station; Switch Board; Systems: Alternating Current; Storage Battery; Underground-Conduit and Third-Rail. Location and Remedies of Faults.

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 166

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BOILERS AND ENGINES

A short, practical course prepared for Steam Engineers, Engine Builders, Designers, Draftsmen, Inventors, Dealers in Steam Machinery and Supplies, Inspectors, Students and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Heat.
Elements of Chemistry.
Construction of Boilers.
Types of Boilers.
Gas Producers.
Gas Engines.
Boiler Accessories.
Steam Pumps.
Steam Engine Part I.
Indicators.
Valve Gears.
Steam Engine Part II.
*Marine Boilers.
*Marine Engines.
*Locomotive Boilers and Engines Part I.
*Locomotive Boilers and Engines Part II.

*Optional.

Tuition $25.00. Payable Monthly.

SYNOPSIS OF COURSE

PRELIMINARY STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY } SEE SYNOPSIS PAGE 166

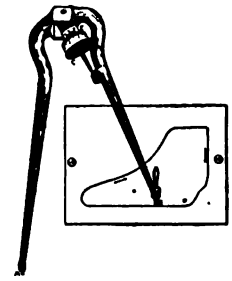
STEAM BOILERS

CONSTRUCTION OF BOILERS. Materials; Testing; Punching; Drilling; Riveting; Joints; Staying; Tubes; Flues; Calking; Requirements; Grate Area; Draft; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Formulas for Riveted Joints; Flues, Tubes and Stays.

TYPES OF BOILERS: Multitubular; Vertical; Manning; Fire Engine; Water-Tube Boilers; Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Thorneycroft; Field. Marine Boilers; Locomotive Boilers.

BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels; Composition and Heat Value of Fuels. Care of Boilers.

MARINE BOILERS: Cylindrical; Water Tube; Construction: Riveting; Flanging; Furnaces; Tubes and Stays. Dimensions: Grate; Heating Surface; Details: Valves; Gages; Salinometer; Hydrokimeter. Draft: Mechanical Stokers; Fuels. Stoking; Cleaning and Banking; Repairs. Launch Boilers.



Water-tube Boilers.

STEAM ENGINES

PUMPS: Principles of Action; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves: Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

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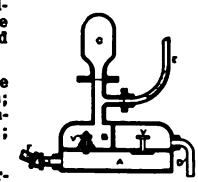
PARTS OF STEAM ENGINE: Cylinder; Piston; Crank; Crosshead; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping. Accessories: Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine; De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power; Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption.



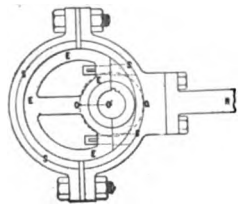
VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagram; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy Valve Gears. Other Valves: Piston; Double Ported; Trick; Corliss. Methods of Balancing Valves.

ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter Brake; Log of Test.

MARINE ENGINES: Propulsion; Types of Marine Engines; Nautical Terms; Details of Engines; Starting Gear; Condensers; Air Pump; Circulating Pump; Auxiliary Machinery. Propellers: Material; Shape; Pitch; Slip; Negative Slip; Twin and Triple Screws. Fittings: Valves and Cocks; Water Service. Management: Lubrication; Hot Bearings; Linking Up; Stopping. Emergencies: Broken Cylinder Head, Crank Shaft and Piston. Breaking of Eccentric; Breaking Down of Air Pump; etc.

LOCOMOTIVE BOILERS: Belpaire; Wootten; Lentz; Details; Materials; Firebox; Stays; Water Table; Grate; Ash Pan; Dampers; Fuels; Rate of Combustion; Smoke Box; Exhaust Nozzle; Petticoat Pipe; Stack. Boiler Fittings: Valves; Whistle; Gages; Blower; Injectors.



LOCOMOTIVE ENGINES: Piston; Crosshead; Connecting Rod; Parallel Rods; Valve Motion; Reversing Gear; Setting Valves; Running Gear; Counterbalancing. Types: Eight Wheeled; Forney; Columbia; Atlantic; Mogul; Consolidation; Decapod. Compound Locomotives. Signals: Targets; Semaphores; Block Signals; Train Signals; Flags. Running: Firing; Fuels; Use of Steam; Cut Off; Learning the Road; Grades; Handling Trains; Inspection; Repairs; Emergencies; Train Rules.

SPECIAL MARINE

A concise course prepared for Marine Engineers, Firemen, Stokers, Oilers, Owners of Launches, Dealers in Marine Machinery and Supplies, Steamboat Officers, Inspectors, Students and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Heat.
Elements of Chemistry.
Gas Producers.
Gas Engines.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Marine Boilers.
Steam Pumps.
Steam Engine Part I.
Indicators.
Valve Gears.
Steam Engine Part II.
Marine Engines.

*Optional.

Tuition $25.00. Payable Monthly.

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SYNOPSIS OF COURSE

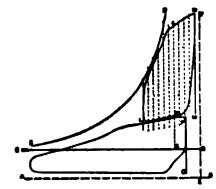
PRELIMINARY STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY SEE SYNOPSIS PAGE 166

STEAM BOILERS

CONSTRUCTION OF BOILERS: Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; General Requirements; Grate Area; Draft; Tubes; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Formulas for Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Chimney.

TYPES OF BOILERS: Cornish; Lancashire; Galloway; Multitubular; Vertical; Manning; Cochrane; Fire Engine; Water-Tube Boilers; Babcock & Wilcox; Root; Heine; Almy; Cahall; Bellville; Yarrow; Thorneycroft; Field.



BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus: Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Calorimeters; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels: Composition and Heat Value of Fuels. Care of Boilers: Fittings; Feed Water; Firing; Cleaning; Inspection; Testing.

MARINE BOILERS: Cylindrical; Water Tube; Gunboat Boilers. Construction: Materials; Testing; Shell; Riveting; Flanging; Furnaces; Tubes and Stays. Dimensions: Grate; Heating Surface; Size of Boiler. Details: Valves; Gages; Pumps; Salinometer; Hydrokineter; Lagging. Draft: Closed Ash-pit; Closed Stokehole; Kafer's Method; Induced Systems. Mechanical Stokers; Fuels. Getting up Steam; Stoking; Cleaning and Banking; Repairs. Types and Advantages of Water-tube Boilers. Launch Boilers.

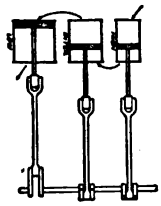
STEAM ENGINES

PUMPS: Principles of Action; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves: Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank; Crosshead; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping. Accessories; Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine: De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power; Table of Engine Constants; Measuring Area of Card; Plainmeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption.

VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagrams; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy Valve Gears. Other Valves: Piston; Double Ported; Trick; Corliss, Methods of Balancing Valves.



ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter Brake; Log of Test.

MARINE ENGINES: Propulsion; Types of Marine Engines; Nautical Terms; Details of Engines; Starting Gear; Condensers; Air Pump; Circulating Pump; Auxiliary Machinery. Propellers: Material; Shape; Pitch; Slip; Negative Slip; Twin and Triple Screws. Fittings: Valves and Cocks; Water Service. Management: Lubrication; Hot Bearings; Linking Up; Stopping. Emergencies; Broken Cylinder Head, Crank Shaft and Piston. Breaking of Eccentric; Breaking Down of Air Pump; etc.

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Mailing Department

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SPECIAL LOCOMOTIVE

A concise course prepared for Locomotive Engineers, Firemen, Switchmen, Brakemen, Towermen, Flagmen, Signalmen, Section Hands, Students and all others interested in Railroading.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Heat.
Elements of Chemistry.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Steam Engine Part I.
Indicators.
Valve Gears.
Steam Engine Part II.
Locomotive Boilers and Engines Part I.
Locomotive Boilers and Engines Part II.
Air Brake.

*Optional.

Tuition $25.00. Payable Monthly.

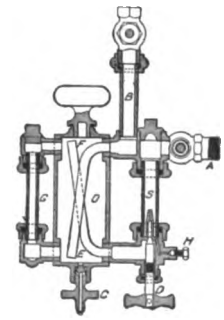
SYNOPSIS OF COURSE

PRELIMINARY STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY SEE SYNOPSIS PAGE 166

STEAM BOILERS

CONSTRUCTION OF BOILERS: Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; General Requirements; Grate Area; Draft; Tubes; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Formulas for Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Uptake; Chimney.



TYPES OF BOILERS: Multitubular; Vertical; Manning; Fire Engine; Water-Tube Boilers; Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Yarrow; Thorneycroft; Field. Marine Boilers; Locomotive Boilers.

BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Calorimeters; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels; Composition and Heat Value of Fuels. Care of Boilers: Fittings; Feed Water; Firing; Cleaning; Inspection; Testing.

STEAM ENGINES

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank; Crosshead; Valve; Eccentric; Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping. Accessories: Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication. Steam Turbine: De Laval; Parsons; Advantages over Reciprocating Type.

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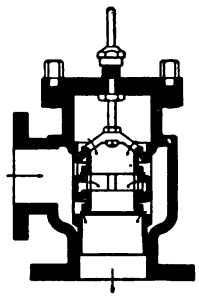
INDICATORS: Diagrams; Mean Effective Pressure. Watts Indicator; Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power; Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption.

VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagrams; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy Valve Gear. Other Valves: Piston; Double Ported; Trick; Corliss. Methods of Balancing Valves.



ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter Brake; Log of Test.

LOCOMOTIVE BOILERS: Belpaire; Wooten; Lents; Details; Materials; Firebox; Stays; Water Table; Grate; Ash Pan; Dampers; Fuels; Rate of Combustion; Smoke Box; Exhaust Nozzle; Petticoat Pipe; Stack; Boiler Fittings: Valves; Whistle; Gages; Blower; Injectors.

LOCOMOTIVE ENGINES: Piston. Crosshead; Connecting Rod; Parallel Rods; Valve Motion; Reversing Gear; Setting Valves; Running Gear; Counterbalancing. Types: Eight Wheeled; Forney; Columbia; Atlantic; Mogul; Consolidation; Decapod. Compound Locomotives. Signals: Targets; Semaphores; Block Signals; Train Signals; Flags. Running: Firing; Fuels; Use of Steam; Cut Off; Learning the Road; Grades; Handling Trains; Inspection; Repairs; Emergencies; Train Rules; Time Tables. Specifications for Engine and Tender.

AIR BRAKE

RAILWAY BRAKES: Hand; Vacuum; Compressed Air; Straight Air Brake; Automatic Brake. Westinghouse and New York Air Brakes. Details.

AUTOMATIC BRAKE: Parts: Pump; Governor; Engineer's Valve; Reservoir; Gages; The Triple Valve; Brake Cylinders; Air Pump: Description; Operation; Brake Rigging; Plan of Car; Brake Shoe Pressure; Driving Wheel Brakes; High Speed Brake: Detail Parts.

HANDLING AIR BRAKES AND SIGNALS: Service and Emergency Application; Cutting out Brakes; Defects and Accidents; General Instructions; Systems of Air Signals.

SPECIAL REFRIGERATION

A concise course prepared for Refrigeration Engineers, Stationary Engineers, Marine Engineers, Firemen, Consulting Engineers, Instructors, Students and all those interested in Mechanical Refrigeration.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Heat.
Elements of Chemistry.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Steam Pumps.
Steam Engine Part I.
Indicators.
Valve Gears.
Steam Engine Part II.
Refrigeration Part I.
Refrigeration Part II.

*Optional.

Tuition $25.00. Payable Monthly.

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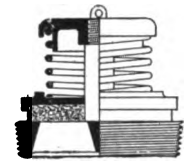
SYNOPSIS OF COURSE

PRELIMINARY STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY SEE SYNOPSIS PAGE 166

STEAM BOILERS AND ENGINES

CONSTRUCTION OF BOILERS: Materials; Testing; Punching; Drilling; Riveting Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; Horse Power; General Requirements; Grate Area; Draft; Tubes; Steam and Water Spaces; Heating Surface; Water Level; Strength of Boiler Shell; Formulas for Thickness and Allowable Pressure; Equations and Formulas for Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Uptake; Chimney.



TYPES OF BOILERS: Cornish; Lancashire; Galloway; Multitubular; Vertical Boilers; Manning; Cochrane; Fire Engine; etc. Water Tube Boilers: Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Yarrow; Thorneycroft; Field. Return and Through Tube Marine Boilers; Locomotive Boilers.

BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Calorimeters; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels: Coal; Coke; Wood; Petroleum; Composition and Heat Value of Fuels. Care of Boilers: Fittings; Feed Water; Firing; Cleaning; Inspection; Testing.

PUMPS: Principles of Action; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves: Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank Crosshead; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed. Pumping Accessories: Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine; De Laval; Parsons; Advantages over Reciprocating Type.

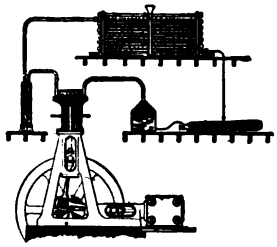
INDICATORS: Diagrams: Mean Effective Pressure. Watts Indicator; Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power. Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption.

VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagrams; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy valve Gears. Other Valves: Piston; Double Ported; Trick; Corliss. Methods of Balancing Valves.

ACTION OF HEAT: Gases: Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

REFRIGERATION

DEFINITIONS: Unit of Refrigeration; Specific Heat; Latent Heat; Thermometers; Fahrenheit; Centigrade; Reaumur. Theory of Refrigeration; Systems: Brine System; Direct Expansion. Refrigerating Agents: Ammonia; Carbonic Acid; Sulphur Dioxide; Air. Tables of Temperatures, Pressures and Weight of Ammonia.



SYSTEMS: Compression; Absorption. Evaporators. Brine Tanks and Coils; Coolers; Direct Expansion. Compressors: Single and Double Acting; Vertical and Horizontal; Water Jacketed and Internally Cooled. Details: Valves; Piston; Stuffing Box; Water Jacket; Alignment; Lubrication; Losses. Condensers: Function; Types: Submerged; Atmospheric; Double Pipe; Means of Distributing Water. Oil Separator: Use and Construction. Ammonia Receiver or Storage Tank. Use and Construction. Pressure Gauges.

BRINE: Chloride of Calcium; Salt; Making Brine; Tables of Weights, Specific Heat and Freezing Point.

MANAGEMENT OF REFRIGERATING MACHINERY: Cleanliness; Loss of Efficiency; Strength of Brine; Loss of Ammonia; Proportions of Parts.

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ENGINEERS' COURSE

This course is designed to prepare Stationary Engineers for License Examinations of all Grades.

INSTRUCTION PAPERS IN THE COURSE

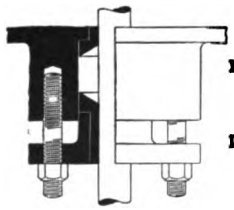
Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Heat
Elements of Chemistry.
Boiler Accessories.
Steam Pumps.
Steam Engine Part I.
Indicators.
Valve Gears.
Steam Engine Part II.
Gas Producers.
Gas Engines.

Tuition $18.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.



ARITHMETIC PART II

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

ARITHMETIC PART III

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight; Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

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HEAT

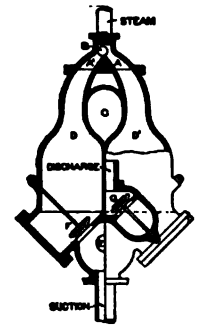
DEFINITION AND NOTATION: Definition of Heat; Amount of Heat; Degree of Heat; Thermometer: Temperature; Fahrenheit; Centigrade; Reaumur. Freezing and Boiling Points. Notation: Absolute Temperature; Changing from one Scale to another.

HEAT EFFECTS: Expansion: Cubical; Linear; Coefficients of Expansion; Expansion of Solids, Liquids and Gases. Liquefaction: Laws of Fusion; Table of Melting Points; Vaporization; Evaporation; Boiling; Table of Boiling Points; Boiling under Pressure and in Vacuum. Distillation; Conduction; Convection; Radiation.

THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

PRACTICAL APPLICATIONS: The Steam Engine and Hot-Air Engine; Manufacture of Ice; Production of Liquid Air.

ELEMENTS OF CHEMISTRY



FUNDAMENTAL PRINCIPLES: Physical and Chemical Changes; Mechanical Mixture; Molecules and Atoms.

ELEMENTS: Table of Elements with Symbols, etc. Atomic Weight; Vapor Density; Law of Definite Weight; Valence; Combining Value. Equations, Factors and Products. Saturated Solution.

PROPERTIES: Physical and Chemical Properties of Oxygen; Hydrogen; Nitrogen, Chemistry of Air and Water; Carbon: Forms and Compounds. Illuminating Gas; Water Gas; Coal Gas; Composition. Combustion: Carbon Monoxide; Carbon Dioxide.

METALS: Sodium: Properties; Compounds. Calcium: Properties; Compounds.

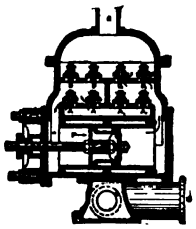
ACIDS: Manufacture of Sulphuric, Nitric, and Hydrochloric Acids.

STEAM ENGINES

PUMPS: Principles of Action; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves: Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank Crosshead; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping Accessories: Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine; De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Watts Indicator; Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power. Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption from Indicator Card.



VALVE GEARS: Slide Valve; Details; Operation; Eccentric; Valve Diagrams; Zeuner Diagram; Design of Slide Valve; Size of Parts; Setting; Equal Lead; Equal Cut Off. Reversing Gears; Stephenson; Gooch; Allen; Joy valve Gears. Other Valves: Piston; Double Ported; Trick; Corliss. Methods of Balancing Valves.

ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed: Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Indicators; Scales; Meters; Gages; Calorimeter Brake; Log of Test.

STEAM TURBINE: Steam Consumption, etc.

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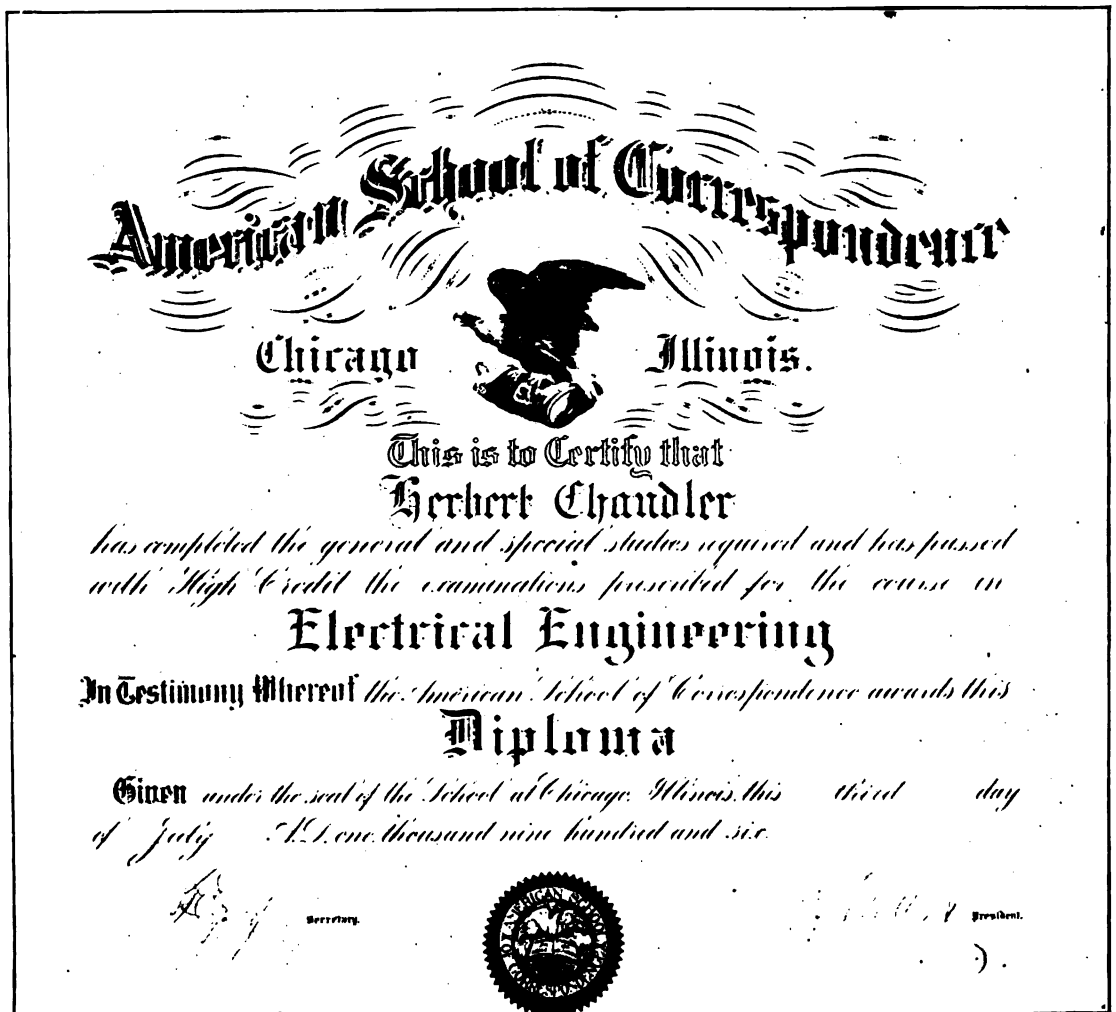

American School of Correspondence

Chicago Illinois.

This is to Certify that

Herbert Chandler

has completed the general and special studies required and has passed with High Credit the examinations prescribed for the course in

Electrical Engineering

In Testimony Whereof the American School of Correspondence awards this

Diploma

Given under the seal of the School at Chicago, Illinois, this third day of July A.D. one thousand nine hundred and six.

Secretary. President.

Reduced Facsimile of Diploma. (Actual Size 16x21)

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DEPARTMENT OF

CIVIL ENGINEERING

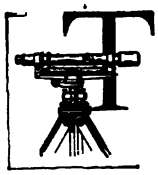
Partial list of the well-known authorities and educators who personally have prepared the instruction papers for correspondence study.

FREDERICK E. TURNEAURE, C. E., Dean, University of Wisconsin.
ALFRED E. PHILLIPS, C. E., Ph. D., Prof., Armour Inst. of Technology.
LOUIS DERR, S. B., A. M., Professor, Mass. Inst. of Technology.
EDWARD ROSE MAURER, B. C. E., Professor, University of Wisconsin.
EDWARD A. TUCKER, S. B., Architectural Engineer.
WALTER LORING WEBB, C. E., Author, "Railroad Engineering."
AUSTIN T. BYRNE, Civil Engineer.
ERVIN KENISON, S. B., Mass. Institute of Technology.
NATHAN R. GEORGE, JR., A. M., Mass. Institute of Technology.
A. MARSTON, C. E., Dean, Iowa State College.

COURSES

COMPLETE CIVIL ENGINEERING
MUNICIPAL ENGINEERING
STRUCTURAL ENGINEERING
RAILROAD ENGINEERING
SURVEYING
HYDRAULICS
STRUCTURAL DRAFTING

CIVIL ENGINEERING



THE demands made upon the Civil Engineer call for technical training along various lines. This branch of engineering includes the division of the land on which we live as well as the design and construction of the foremost structures in the world. Among the problems with which the Civil Engineer is confronted may be mentioned the laying out of cities, the design and construction of bridges, the location of railroads, the building of canals, sewers and streets, and the dredging of harbors.

The courses in Civil Engineering aim to equip the student with the underlying principles in order to make him efficient, both in the field and office. Thorough instruction is given in plane surveying, including the care and adjustment of instruments, leveling, transit work and computation. Illustrations show the methods of keeping field notes and of plotting them in the office.

The Municipal, Structural and Railroad Engineering Courses cover fully all subjects pertaining to these specialized branches of Civil Engineering.

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COMPLETE CIVIL ENGINEERING

INCLUDING MECHANICAL DRAWING

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Freehand Drawing.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.
Perspective Drawing.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Plane Surveying Part I.
Plane Surveying Part II.
Plane Surveying Part III.
Plotting and Topography.
Strength of Materials Part I.
Strength of Materials Part II.
Masonry Construction Part I.
Masonry Construction Part II.
Hydraulics.
Water Supply Part I.
Water Supply Part II.
Sewers and Drains.
Highway Construction Part I.
Highway Construction Part II.
Statics.
Steel Construction Part I.
Steel Construction Part II.
Steel Construction Part III.
Steel Construction Part IV.
Bridge Design.
Railroad Engineering Part I.
Railroad Engineering Part II.
Railroad Engineering Part III.
Building Superintendence Part I.
Building Superintendence Part II.
Contracts and Specifications.
Legal Relations.
*Types of Boilers.
*Boiler Accessories.
*Steam Pumps.
*Steam Engine Part I.
*Indicators.
*Locomotive Boilers and Engines Part I.
*Locomotive Boilers and Engines Part II.

*Optional.

Tuition $120.00. Payable Monthly.

Note. For Synopsis see Courses on Municipal, Structural and Railroad Engineering, Pages 91 to 100.

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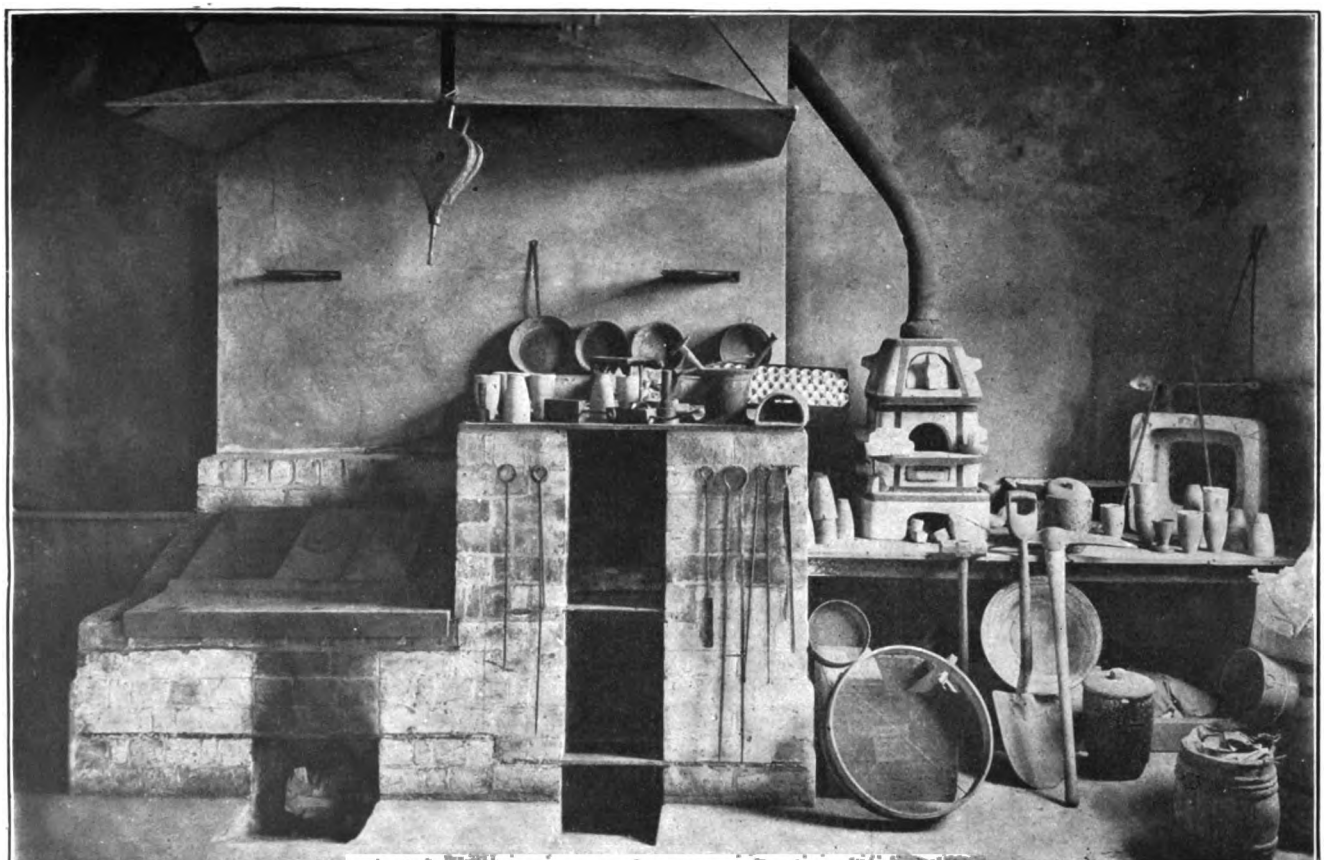

Laboratory, American School of Correspondence in Australasia

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MUNICIPAL ENGINEERING

Prepared for Municipal Engineers and their Assistants, County Surveyors, Highway Commissioners, Sanitary Engineers, Contractors, Instrument Men, Rodmen, Chainmen, Inspectors and all those engaged in the Designing, Laying Out or Inspecting of Material for Highways, Dams and Sewers.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
*Mechanical Drawing Part IV.
*Mechanical Drawing Part V.
*Mechanical Drawing Part VI.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Plane Surveying Part I.
Plane Surveying Part II.
Plane Surveying Part III.
Plotting and Topography.
Strength of Materials Part I.
Strength of Materials Part II.
Masonry Construction Part I.
Masonry Construction Part II.
Hydraulics.
Water Supply Part I.
Water Supply Part II.
Sewers and Drains.
Highway Construction Part I.
Highway Construction Part II.
*Types of Boilers.
*Boiler Accessories.
*Steam Pumps.
*Steam Engine Part I.
*Indicators.
*Elements of Electricity.
*The Electric Current.
*Theory of Dynamo-Electric Machinery.
*Direct Current Dynamos.
*Direct Current Motors.

*Optional.

Tuition $80.00. Payable Monthly.

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SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 166

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

MATHEMATICS

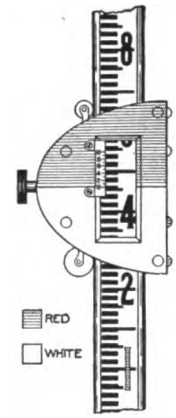
ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

PLANE SURVEYING

MEASUREMENTS: Tapes; Chain; Accessible and Inaccessible Points; Sags and Directions; Chaining; Slope Measurements; Areas; Perpendiculars; Erect and Fall from a Given Line; Parallel Measurements to a Given Point; Prolonging Beyond Obstacles; Surveying Fields; Areas; Offsets and Tie-Lines. Inaccessible Areas; Valleys and Hills; Keeping Field Notes: By Sketches Alone; By Notes Alone; By Notes and Sketches. Vernier: Direct; Retrograde; Construction; Use.

LEVELING: Level Bubble; Hand Level; Abney Clinometer; Field Notes; Height and Elevation. Levels: Wye; Dumpy; Precise; Spirit. Adjustments; Uses. Rods: Kinds; Use; Method of Reading.

TRANSIT: Makes; Purpose; Use; Adjustments; Construction; Compass. Triangulation: Method; Preliminary Object; Field Notes; Stadia: Height; Instruments; Method; Different Rods.



PLOTTING AND TOPOGRAPHY

DEFINITIONS: Contours; Telemetry; Office Work; Reduction of Observations; Plotting of Profiles; Plotting of Stadia Survey Notes; Plotting of Maps by Projection; Three-point Problem; Topographical Signs; Lettering and Border Line.

DRAWING INSTRUMENTS: Three-armed Protractor; Pantograph; Stadia Slide Rule; Polar Planimeter; Stadia Reduction Table; Table of Dimensions and Co-ordinates for Map Construction.

STRENGTH OF MATERIALS

RESISTANCE AND ELASTICITY: Average Weights; Stresses and Deformations. Experimental Laws; Tension; Compression; Shear; Factors of Safety and Working Stresses.

BEAMS: Cantilever and Simple Beams; Reactions of Supports; Vertical Shear; Bending Moments; Internal Stress and External Forces; Fundamental Formulas; Moments of Inertia; Center of Gravity; Maximum Bending Moment; Safe Loads; Designing; Modulus of Rupture; Comparative Strength; Iron and Steel I-Beams: Cast-Iron Beams; Deflection; Relation between Deflection and Stress. Beams of Uniform Strength. Continuous Beams.

COLUMNS: Cross-sections; General Principles; Radius of Gyration; Designing. Torsion; Shafts for Transmitting Power. Combined Stresses; Horizontal Shear.

TESTING: Timber; Brick; Cement; Mortar; Stone; Cast Iron; Wrought Iron; Steel. Resilience: Sudden Loads and Impact; Modulus; Elastic Resilience of Beams; Ultimate Resilience; Modern Experiments.

TENSION AND COMPRESSION: Elongation under own Weight; Bar of Uniform Strength; Longitudinal Impact; Centrifugal Stress; Shrinkage of Hoops.

SHEAR AND TORSION: Stresses Caused by Shear; Resilience under Shear; Coefficients of Elasticity: Hollow and Solid Shafts; Shaft Couplings.

MASONRY CONSTRUCTION

CLASSES OF MASONRY: First and Second Class; Arch Culverts; Centering; Wing Walls; Pointing; Grouting; Freezing; Brick Masonry; Dry Walls; Dry Box Culverts; Pipe Culverts.

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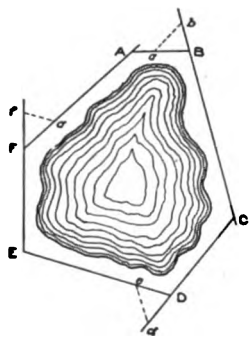
FOUNDATIONS: Excavation; Artificial Foundations; Timber; Piles; Cofferdam; Iron; Blast Furnace Slag; Concrete: Mixing; Compressive Strength; Period of Repose.

CEMENT: Hydraulic; Natural; Portland; Characteristics of Portland Cement; Cement Test; Effect of Age; Quick and Slow Set Cement. Soundness; Fitness; Specifications.

MORTAR: Sand; Water; Strength of Mortar; Shearing; Compressive and Tensile Strength; Effect of Frost; Permanency; Data; Specifications.

HYDRAULICS

HYDROSTATICS: Head; Pressure; Center of Pressure; Pressures on Opposite Sides of a Plane; Loss of Weight in Water; Flotation.



HYDRAULICS: Velocity and Discharge; Velocity of Approach; Pressure Head; Velocity Head; Energy of a Jet; Impulse and Reaction; Orifices: Coefficients; The Miner's inch; Submerged Orifices; Measurement of Water by Orifices; Energy of Discharge; Canal Lock: Weirs: Hook Gauge; Francis' Formulas; Waste Weirs and Dams; Tubes; Nozzles, and Jets; Effective and Lost Head; Water Meter.

PIPES: Losses of Head; Discharge; Short and Long Pipes; Hydraulic Gradient; Nozzle; House-Service Pipes; Mains and Branches; Pumping through Pipes; Fire Hose; Flow in Conduits and Canals; Conduits; Bazin's Formula; Sewers, Ditches and Canals; Loss of Head; Energy of Flow.

WATER POWER: Measurements; Test of Small Motor; Pressure of Flowing Water; Impulse and Reaction; Curved Pipes and Channels; Water Wheels; Conditions of High Efficiency; Kinds of Wheels; Turbines; The Reaction Wheel; Theory; Design; Guides and Vanes.

WATER SUPPLY

SOURCES: Consumption per Capita; Fire Demands; Surface Water; Lakes and Rivers; Rainfall; Ground Water; Artesian Supplies. Quality of Ground Waters.

CONSTRUCTION OF WORKS: River and Lake Intakes; Wells and Galleries; Impounding Reservoirs: Capacity; Location; Construction; Dams; Conduits and Pipe Lines. Canals. Distributing Systems; Reservoirs; Stand Pipes and Tanks. Pressure; Fire Streams; Hydrants; Service Connections; Details. Pumping Station Machinery. Operation and Maintenance: Water Rates; Use of Meters.

PURIFICATION OF WATER: Sedimentation; Filtration; Various Forms of Filters; Other Methods of Purification.

SEWERS AND DRAINS

SYSTEMS: Requirements; Combined and Separate. Disposal of Sewage; Streams and Tidal Waters; Dilution; House Sewerage; Storm Water; Velocity and Discharge; Size and Shape of Sewers. Flushing; Ventilation; Surveying and Plotting.

DESIGN: Locating; Grade, Size and Depth of Sewers. Inverted Siphon; Sub-drains; Connection; Mandoles; Inlets; Flushing; Tanks; Pumping of Sewers; Interception Sewers and Over-flows. Details: Sewer-Barrel; Plates; Pipe Sewers; Intercepters and Over-flows; Foundations.

SPECIFICATIONS: Contract; Estimate of Cost; Specifications for Materials; Pipe; Stone; Castings; Sand; Cement; Pack and Timber; Excavation; Shoring and Sheating; Railroad Crossings; Provisions; Imperfect Work; Unnecessary Delays; Extra Work; Commencement and Completion; Position of Engineer; Duties of Contractor; Weight of Materials. Cost of Excavating, Back-filling and Sheating. Laying Sewer-pipe. Interference with Existing Structures and Water Course; Rock Trenches.

CONSTRUCTION: Foundations; Concrete; Stone and Brick Masonry; Laying Pipe-sewers; Laying Sub-drains. Back Filling; Final Inspection. Preparation; Contract Work or Day Labor; Bids; Laying out Work; Lining of Trenches; Over-sight and Measurement; Inspection; Trenching by Hand; Excavating Machinery; Laying Sewer Pipe. Masonry Sewers, Template; Concrete Arch for Brick Sewers. Foundations; Pumping and Draining; Cofferdam; Puddle-walls.

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HIGHWAY CONSTRUCTION

COUNTRY ROADS: Object of Roads; Resistance to Traction; Location of Roads; Topography; Bridge Sites; Contours; Drainage; Earth Work; Tools; Road Coverings.

STREETS: Laying Out; Arrangement; Width; Grades; Transverse Grade and Contour; Sub-division; Drainage of Streets; Surface Drainage; Gutters; Catch Basins; Street Intersections; Street Lines and Monuments; Street Profiles.

PAVEMENTS: General Considerations; Selection; Cost; Economy; Maintenance; Tests. Granite Blocks; Sandstone; Blue-stone; Asphalt; Asphaltic Cement. Bituminous Limestone; Sandstone. Analysis and Test of Asphalts; Cost; Paving Pitch; Brick-clay; Brick for Paving; Resistance to Crushing; Absorption. Wood; Sand. Cobble Stone; Plank Pavement; Granite Blocks; Manner of Laying: Foundation; Joint Filling; Bituminous Cement; Sandstone Block; Limestone; Steep Grades; Granite; Cost of Construction. Wood Pavement. Foundation; Expansion; Joints; Wear; Durability; Asphalt Wood Pavements; Cedar Pavements. Asphalt and Coal Tar: Broken Stone: Macadam's Methods; Layers; Binding; Rolling.

MISCELLANEOUS PAVEMENTS: Gravel Roads; Bituminous Macadam; Concrete Macadam; Stone Track Ways; Artificial Granite Blocks; Plank Roads; Furnace Slag; Florida Clay; Tar; Artificial Stone; Hydraulic Cement Pavements; Construction. Specifications for Proportion of Road-bed.

STEAM BOILERS AND ENGINES

TYPES OF BOILERS: Cornish; Lancashire; Galloway; Multitubular; Vertical Boilers; Manning; Cochrane; Fire Engine; etc. Water Tube Boilers: Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Yarrow; Thorneycroft; Field. Return and Through Tube Marine Boilers; Locomotive Boilers.

BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Calorimeters; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels; Coal; Coke; Wood; Petroleum; Composition and Heat Value of Fuels. Care of Boilers: Fittings; Feed Water; Firing; Cleaning; Inspection; Testing.

PUMPS: Principles of Action; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves: Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank Crosshead; Valve; Eccentric. Types: Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping Accessories; Condensers; Cooling Towers; Fly Wheel; Governor; Lubrication; Steam Turbine; De Laval; Parsons; Advantages over Reciprocating Type.

INDICATORS: Diagrams; Mean Effective Pressure. Watts Indicator; Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power. Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards: Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults: Causes and Remedies; Calculation of Steam Consumption.

ELECTRICITY

ELEMENTS OF ELECTRICITY: Magnetism; Magnetic Induction; Static Electricity; Insulators; Conductors; Charges; Electric Machines; Condensers; Dynamic Electricity; E. M. F.; Resistance; Cells; Solenoid; Electro-magnets; Induction Coils; Applications; Telephone; Telegraph.

ELECTRIC CURRENT: Resistance; Conductance; Tables; Calculations; Coefficients; Wire Tables; Ohm's Law; Circuits; Fall of Potential; Electric Energy; Power; Coulomb; Joule; Watt; Mechanical Equivalent; Plants; Commercial Efficiency.

THEORY OF DYNAMO-ELECTRIC MACHINERY: Symbols; Tables; Lines of Force; Induction; The Generator; Commutator; Permeability; Saturation; Hysteresis; Armature Reaction; Neutral Point; Lead; Demagnetization; Fields; Series, Shunt and Compound Windings.

DIRECT CURRENT DYNAMOS: Classes; Curves; Long and Short Shunt; Field Magnets; Armature; Windings; Commutators; Brushes; Brush Holders; Field Magnets; Field Coils; Sparking; Installation; Operation; Testing. **DESIGN:** Formulas; Armature Conductor; Windings; Magnetic Density; Losses in Armature; Magnet Frame; Magnetic Flux; Air Gaps; Armature Core; Field Cores and Yoke; Pole Pieces; Armature Reactions; Efficiency.

DIRECT CURRENT MOTORS: Principles; Equations; Counter E. M. F.; Torque and Speed; The Prony Brake; Shunt and Series Motors; Compound Motor; Series Motor; Regulation; Transformers; Generator and Motor in Combination; Calculations.

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STRUCTURAL ENGINEERING

INCLUDING MECHANICAL DRAWING

Prepared for Structural Engineers, Architects, Bridge Engineers, Draftsmen in the Engineering Department of Bridge Works, Employes in Bridge Works, Contractors and all those engaged in Structural Work, either in Designing, Inspecting or Construction.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Freehand Drawing.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.
Perspective Drawing.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Plane Surveying Part I.
Plane Surveying Part II.
Plane Surveying Part III.
Plotting and Topography.
Strength of Materials Part I.
Strength of Materials Part II.
Statics.
Steel Construction Part I.
Steel Construction Part II.
Steel Construction Part III.
Steel Construction Part IV.
Bridge Design.
Building Superintendence Part I.
Building Superintendence Part II.
Contracts and Specifications.
Legal Relations.
*Types of Boilers.
*Boiler Accessories.
*Steam Pumps.
*Steam Engine Part I.
*Indicators.

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*Optional.

Tuition $80.00. Payable Monthly.

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SYNOPSIS OF COURSE

GENERAL STUDIES

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MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS } SEE SYNOPSIS PAGE 169

PLANE SURVEYING

MEASUREMENTS: Tapes; Chain; Accessible and Inaccessible Points; Sags and Directions; Chaining; Slope Measurements; Areas; Perpendicular; Erect and Fall from a Given Line; Parallel Measurements to a Given Point; Prolonging Beyond Obstacles; Surveying Fields; Areas; Offsets and Tie-Lines. Inaccessible Areas; Valleys and Hills; Keeping Field Notes: By Sketches Alone; By Notes Alone; By Notes and Sketches. Vernier: Direct; Retrograde; Construction; Use.

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SHEAR AND TORSION: Stresses Caused by Shear; Resilience under Shear; Coefficients of Elasticity: Hollow and Solid Shafts; Shaft Couplings.

GRAPHIC STATICS

PRINCIPLES AND METHODS: Force Triangle; Force Polygon; Conditions of Equilibrium; Stresses in Crane Truss; Stresses in Polygonal Frame; Properties of the Equilibrium Polygon; Reactions of Beams; Simple Beams under Concentrated Loads; Under Uniform Loads; Overhanging Beams; Center of Gravity and Moment of Inertia of Cross-sections; Graphical Arithmetic.

ROOF TRUSSES: Dead and Snow Loads; Stresses Due to Loads. Triangular Roof Truss; Wind Loads; Truss with Fixed Ends; Truss with one End Free; Abbreviated Methods for Wind Stress; Complete Stresses for a Triangular Truss; Crescent; Ambiguous Cases; Unsymmetrical Loads and Trusses.

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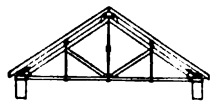
BRIDGE TRUSSES: Loads on Bridge Trusses; Dead Load Stresses. Live Load Stresses in a Warren Truss; In a Pratt. Snow-Load Stresses. Wind Stresses; Stresses due to Initial Tension; Final Maximum and Minimum Stresses; Bowstring Truss; Application; Equilibrium Polygon; Excess Loads; Analysis Plate Girder; Analysis Pratt Truss; Double Quadruple Systems.

ANALYTICS

STRESSES IN ROOF TRUSSES: Loads; Apex; Reactions; External Forces; Internal Stresses; Moments; Lever Arms; Resolution of Forces; Dead-Load Stresses; Snow-Load Stresses; Ends of Roof Trusses; Wind Stresses; Maximum and Minimum Stresses in Roof Trusses; Crescent Roofs; Purlins; Flexure Stresses in Members; Investigation of Roof Trusses; Design of Roof Trusses.

HIGHWAY BRIDGES: Specifications: Live Loads; Dead Loads; Wind Pressure; Length of Span; Limiting Clear Road Ways; Limiting Depth of Punny Trusses; Limiting Washers; Beam Hangers; Jaws; Braces; Test of Structure; Pins, Bearings, Chord and Braces; Turn Buckles; Nuts; Trussing; Batter Bracing Plates; Latticing and Lacing Bars; of Wind; Initial Tension; Strut Stresses; Working Stresses; Span; Camber; Vertical Sway Bracing; Struts; Effect Limiting Size of Sections; Anchorage Sliding Continuous Limiting Length of Span for Double Intersection Bridges; Slope for Batter Braces of Punny Trusses; Side Braces; Proportion of Main Members of Trusses; Floor System; Pin Proportion; Riveting; Complete Design for a Bridge; Investigation and Design.



RAILROAD BRIDGE TRUSSES: Live and Dead Loads; Wind, Snow and Impact; Trusses, Different Kinds; Warren; Wimple, Bowman, and Fink Trusses; Warren Sub-vertical and Double System; Post Truss; True Live Load Shears; Concentrated Excess Loads. Wheel Loads; Double System; Triple and Quadruple Systems; Unsystematical Trusses; Lateral Braces; Economical Depth of Trusses.

BRIDGE DESIGN

HIGHWAY BRIDGE TRUSSES: Definitions; Dead Loads; Kinds of Trusses; Stresses in Web Members; Stresses in Chords; Dead-Load Stresses; Live Loads; Stresses and Shears Due to Live Load; Web Stresses in the Warren Truss; Panel Counter-Braces; Web Stresses in Howe and Pratt Trusses; Ranges of Stress; The Bowstring Truss; Parabolic; other Forms; Snow Load Stresses; Wind. Investigation and Design.

RAILROAD BRIDGE TRUSSES: Dead Loads; Live Loads; Snow, Wind and Impact; Kind of Trusses. True Live Load Shears; One Concentrated Excess Load; Two Concentrated Excess Loads; Locomotive "Wheel" Loads; Shears from Wheel Loads. Tabulation for Locomotive Wheels, Stresses from Locomotive and Train Loads; Remarks on Double Systems; Example of a Double System Truss; Triple and Quadruple Systems; Unsymmetrical Trusses; Lateral Bracing; Economic Depth of Trusses.

STEEL CONSTRUCTION

STRUCTURAL ELEMENTS OF A BUILDING: The Enclosing Walls; Interior Columns and Bearing Partitions; The Floors; The Roof; Use of Handbooks on Steel; Tables; Building Laws and Specifications; The Steel Frame; Fireproof and Fire-resisting Materials; Floor and Roof Arches; Selection of System; Partitions; Fire-resisting Wood; Beams and Girders; Determination of Load; Distribution of Load; Beam Plates.

COLUMNS: Shapes used; Calculation of Sections; Cast Iron Columns; Concrete and Steel Columns; Trusses; Selection; Bracing.

CONNECTIONS AND DETAILS OF FRAMING: Column Caps, Bases and Splices; Roof Details; Inspection; Drawings and Specifications; Shop Practice; Standard Frames; Invoices; Estimating; Foundations; High Building Construction; Wind Pressures; Mill Building Construction; Detailing; Riveting; Standard Connections; Details from Framing Plan; Column Details; Shaft Details; Functions of Flanges and Webs; Proportioning Flanges; Depth of Webs; Use of Stiffeners; Cutting off Flange Plates; Spacing of Flange Rivets; Flange Splices; Shop Details of Girders; Standards in Detailing Trusses; Special Notes and Details; Direction of Stress; Stress in Verticals; Stress in Diagonals; Choosing the Section; Use of Gussets; Trussed Stringers.

STEAM BOILERS AND ENGINES

TYPES OF BOILERS: Cornish; Lancashire; Galloway; Multitubular; Vertical Boilers; Manning; Cochrane; Fire Engine; etc. Water Tube Boilers: Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Yarrow; Thorneycroft; Field. Return and Through Tube Marine Boilers; Locomotive Boilers.

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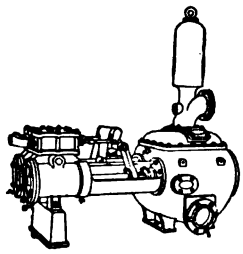
BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Calorimeters; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels; Coal; Coke; Wood; Petroleum; Composition and Heat Value of Fuels. Care of Boilers: Fittings; Feed Water; Firing; Cleaning; Inspection; Testing.



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INDICATORS: Diagrams; Mean Effective Pressure. Watts Indicator; Crosby, Thompson and Tabor Indicators; Reducing Motions; Taking Diagrams; Calculation of Horse Power. Table of Engine Constants; Measuring Area of Card; Planimeter; Indicator Cards; Actual; Ideal; Cards for Compound and Triple Expansion Engines; Combined Cards. Faults. Causes and Remedies; Calculation of Steam Consumption.

ARCHITECTURE

BUILDING MATERIALS AND SUPERINTENDENCE: Limes; Cements and Mortars; Strength; Proportions; Data for Estimating Cost. Stone: Granite; Limestone; Marble; Slate; Testing Building Stone. Brick: Paving Brick; Fire Brick; Glazed and Enameled Brick; Building Brick. Size; Mortar; Construction of Walls; Hollow Walls; Brick Arches; Brick Veneer; Fireplaces. Terra Cotta: Composition and Manufacture. Durability; Inspection. Setting and Pointing. Examples of Construction. Iron and Steel: Girders and Lintels; Supports; Bearing Plates; Chimney Caps, etc. Laths and Plastering. Metal Laths; Stucco. Concrete. Superintendence: Necessity for Superintendence. Visits; Setting out the Building; Inspecting Material; Inspecting Construction; Costs; Contracts.

CONTRACTS AND SPECIFICATIONS: Classes; Drawing Up; Leak; Clauses; Subletting: Assignment. Failure to Complete Work; Insolvency; Insurance; Appliances; Disputes; Condemned Material. Penalties; Cost; Monthly Estimate; Final Acceptance; Definition of "Engineer" and "Contractor." Specifications: Forms; Clauses; Material; Workmanship; Performance; Specifications for Stone Work; Building; Lumber; Cement; Mortar, etc.

LEGAL RELATIONS: The Law of Contracts; Express Contracts; Legality of Contract; Consent; Consideration; The Statute of Frauds; Construction of Contracts; Breach of Contract; Waiver; The Law of Agency; Miscellaneous Matters; Bankruptcy and Insolvency: Certificates; Inspection; Limit of Cost; Invitations to Compete.

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RAILROAD ENGINEERING

INCLUDING MECHANICAL DRAWING

Prepared for Railroad Civil Engineers, Surveyors and Assistants, Chiefs of Sections, Track Foremen, Road Masters, and all those engaged in Railroad Engineering, including Location, Construction and Maintenance.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
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Mechanism.
Heat.
Elements of Chemistry.
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Railroad Engineering Part I.
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Statics.
Steel Construction Part I.
Steel Construction Part II.
Steel Construction Part III.
Steel Construction Part IV.
Bridge Design.
*Types of Boilers.
*Boiler Accessories.
*Steam Engine Part I.
*Locomotive Boilers and Engines Part I.
Locomotive Boilers and Engines Part II.

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*Optional.

Tuition $80.00. Payable Monthly.

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GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM HEAT, ELEMENTS OF CHEMISTRY, METALLURGY } SEE SYNOPSIS PAGE 166

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

MATHEMATICS

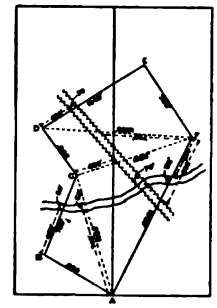
ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS } SEE SYNOPSIS PAGE 169

PLANE SURVEYING

MEASUREMENTS: Tapes; Chain; Accessible and Inaccessible Points; Sags and Directions; Chaining; Slope Measurements; Areas; Perpendiculars; Erect and Fall from a Given Line; Parallel Measurements to a Given Point; Prolonging Beyond Obstacles; Surveying Felds; Areas; Offsets and Tie-Lines. Inaccessible Areas; Valleys and Hills; Keeping Field Notes: By Sketches Alone; By Notes Alone; By Notes and Sketches. Vernier: Direct; Retrograde; Construction; Use.

LEVELING: Level Bubble; Hand Level; Abney Clinometer; Field Notes; Height and Elevation. Levels: Wye; Dumpy; Precise; Spirit. Adjustments; Uses. Rods: Kinds; Use; Method of Reading.

TRANSIT: Makes; Purpose; Use; Adjustments; Construction; Compass. Triangulation; Method; Preliminary Object; Field Notes; Stadia: Height; Instruments; Method; Different Rods.



PLOTTING AND TOPOGRAPHY

DEFINITIONS: Contours; Telemetry; Office Work; Reduction of Observations; Plotting of Profiles; Plotting of Stadia Survey Notes; Plotting of Maps by Projection; Three-point Problem; Topographical Signs; Lettering and Border Line.

DRAWING INSTRUMENTS: Three-armed Protractor; Pantograph; Stadia Slide Rule; Polar Planimeter; Stadia Reduction Table; Table of Dimensions and Co-ordinates for Map Construction.

STRENGTH OF MATERIALS

RESISTANCE AND ELASTICITY: Average Weights; Stresses and Deformations. Experimental Laws; Tension; Compression; Shear; Factors of Safety and Working Stresses.

BEAMS: Cantilever and Simple Beams: Reactions of Supports; Vertical Shear; Bending Moment; Internal Stress and External Forces; Fundamental Formulas; Moments of Inertia; Center of Gravity; Maximum Bending Moment; Safe Loads; Designing; Modulus of Rupture; Comparative Strength; Iron and Steel I-Beams; Cast-Iron Beams; Deflection; Relation between Deflection and Stress. Beams of Uniform Strength. Continuous Beams.

COLUMNS: Cross-sections; General Principles; Radius of Gyration; Designing. Torsion; Shafts for Transmitting Power. Combined Stresses; Horizontal Shear.

TESTING: Timber; Brick; Cement; Mortar; Stone; Cast Iron; Wrought Iron; Steel. Resilience: Sudden Loads and Impact; Modulus; Elastic Resilience of Beams; Ultimate Resilience; Modern Experiments.

TENSION AND COMPRESSION: Elongation under own Weight; Bar of Uniform Strength; Longitudinal Impact; Centrifugal Stress; Shrinkage of Hoops.

SHEAR AND TORSION: Stresses Caused by Shear; Resilience under Shear; Coefficients of Elasticity; Hollow and Solid Shafts; Shaft Couplings.

MASONRY CONSTRUCTION

CLASSES OF MASONRY: First and Second Class; Arch Culverts; Centering; Wing Walls; Pointing; Grouting; Freezing; Brick Masonry; Dry Walls; Dry Box Culverts; Pipe Culverts.

FOUNDATIONS: Excavation; Artificial Foundations; Timber; Piles; Cofferdam; Iron; Blast Furnace Slag; Concrete: Mixing; Compressive Strength; Period of Repose.

CEMENT: Hydraulic; Natural; Portland; Characteristics of Portland Cement; Cement Test; Effect of Age; Quick and Slow Set Cement. Soundness; Fitness; Specifications.

MORTAR: Sand; Water; Strength of Mortar; Shearing; Compressive and Tensile Strength; Effect of Frost; Permanency; Data; Specifications.

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RAILROAD ENGINEERING

SURVEYS: Reconnoissance and Preliminary Surveys; Location Surveys. Simple Curves; Compound Curves; Transition Curves.

CONSTRUCTION: Earthwork: Slopes; Cross-sections; Staking out; Calculations; Methods of Excavation; Blasting. Tunnels: Surveying; Form of Section; Lining and Portals. Construction.

RAILROAD STRUCTURES: Design and Construction of Culverts. Trestles: Pile; Framed. Retaining Walls; Rip Rap. Piers and Abutation Pits; Design; Location; Staking out; Foundation Pits; Pile Foundations. Water Stations; Turntables; Coaling Stations.

TRACK WORK: Materials; Laying Track; Ballasting; Switches and Turnouts; Terminals; Track Maintenance. Tools; Work Trains; Organization; Signaling.

ECONOMICS: Railroad Finances; Gross Revenue; Operating Expenses; Net Revenue; Fixed Charges. Economic Location: Curves; Grades. Improvement of Old Lines. Tables.

STRUCTURAL WORK

STATICS, STEEL CONSTRUCTION, BRIDGE DESIGN SEE SYNOPSIS PAGE 95.

OPTIONAL WORK

TYPES OF BOILERS, BOILER ACCESSORIES, STEAM ENGINE PART I, LOCOMOTIVE BOILERS AND ENGINES SEE SYNOPSIS PAGE 75

SURVEYING

A short, special course prepared for Surveyors, Instrument Men, Rodmen, Chainmen, Draftsmen, etc.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
*Mechanical Drawing Part III.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Plane Surveying Part I.
Plane Surveying Part II.
Plane Surveying Part III.
Plotting and Topography.

*Optional.

Tuition $55.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

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DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight: Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

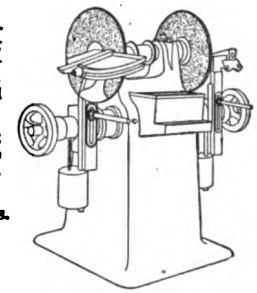
MECHANICS

PROPERTIES OF MATTER: Atoms and Molecules; Solids; Liquids; Gases; Extensibility; Impenetrability; Indestructibility; Inertia; Divisibility; Porosity; Hardness; Tenacity; Brittleness; Malleability; Ductility.

MOTION, VELOCITY AND FORCE: Momentum; Newton's Laws; Parallelogram of Forces; Force Diagrams. Center of Gravity; Falling Bodies; Projectiles; The Pendulum; Kinetic and Potential Energy; Centrifugal Force.

PRINCIPLES OF MACHINES: Levers; Pulleys; Inclined Planes; Wedges; Screws; Laws of Friction; Coefficients of Friction. Tooth Gears: Spur; Worm; Bevel; Helical; Belt, Wire and Rope Gearing. Velocity Ratio; Horse Power Transmitted; etc.

STRENGTH OF MATERIALS: Cohesion; Adhesion; Capillarity; Stress; Deformation; Elastic Limit; Breaking Strength; Coefficient of Elasticity; Tension; Compression; Shear; Torsion; Factor of Safety; Working Stress. Strength of Pipes and Cylinders; Strength of Beams and Columns; Moment of Inertia; Diagrams and Formulas.



HYDROSTATICS: Density; Specific Gravity; Hydrometers; Pressure of Fluids; Hydraulic Press; Head; Pressure Dams and Gates; Coefficients of Flow; Water Motors; Turbines.

PNEUMATICS: Barometers; Mariotte's Law; Suction Pumps.

MECHANISM

REVOLVING BODIES: Mechanism; Motion; Velocity; Surface Speed; Calculation for Diameter and Number of Revolutions; Cylinder and Cones in Direct Contact. Cylinders and Cones Connected by Belts; Stepped and Tapered Cones. Disc and Roller. Tight and Loose Pulleys; Clutches; Other Mechanisms.

SIMPLE MACHINE PARTS: Screws; Levers; Cams; Linkwork; Motion and Power; Application for Machine Shop and Textile Work. Quick Return Motions: Whitworth; Swinging Block.

GEARS: Spur; Annular; Bevel; Worm and Wheel; Velocity Ratios; Trains of Gears.

MECHANICAL DRAWING

PART I

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises in Line Work.

PART II

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

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PART III

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection: True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric; Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.

LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

ALGEBRA PART I

EXPRESSIONS: Symbols; Coefficients and exponents; Symbols of Relation; Symbols of Abbreviation; Positive and Negative Terms; Monomial; Binomial; Trinomial; Polynomials; Similar Terms. Finding Numerical Value by Substitution. Finding Values of Unknown Quantities.

FUNDAMENTAL PROCESSES: Addition; Subtraction; Use of Parentheses; Multiplication; Division; Formulae; Factoring; Highest Common Factor; Lowest Common Multiple.

FRACTIONS: Fractions and Integers; Reduction of Fractions to Lowest Terms; Reduction of Fractions to Entire or Mixed Quantities; Reduction of Mixed Quantities to Fractions; Reduction of Fractions to Lowest Common Denominator; Addition and Subtraction of Fractions; Multiplication and Division of Fractions; Complex Fractions.

ALGEBRA PART II

SIMPLE EQUATIONS: Transposition: Solution of Simple Equations; Solution of Equations Containing Fractions; Literal Equations; Equations involving Decimals; Equations Containing Two Unknown Quantities: Elimination by Addition, Subtraction, Substitution and Comparison.

INVOLUTION AND EVOLUTION: Monomials and Polynomials; Squares, Cubes and Higher Powers. The Radical Sign; Theory of Exponents; Radicals; Reduction of Radicals to Simplest Form; Addition, Subtraction, Multiplication and Division of Radicals. Involution and Evolution of Radicals. Irrational Denominators; Approximate Values.

IMAGINARY QUANTITIES: Multiplication and Division of Imaginary Quantites. Quadratic Surds.

EQUATIONS: Solution of Equations Containing Radicals. Pure and Affected Quadratic Equations; Simultaneous Equations Involving Quadratics.

RATIO AND PROPORTION: Alternation; Inversion; Composition; Division.

PROGRESSION: Arithmetical and Geometrical.

BINOMIAL THEOREM: Formulae; Positive Integers; Finding Terms in an Expansion.

GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles; Acute; Obtuse Complementary; Supplementary; etc. Parallel Lines; Axioms.

FUNDAMENTAL THEOREMS: Plane Figures; Polygons: Equilateral and Equiangular. Quadrilaterals; Circles; Measurements of Angles; Similar Figures; Trapezium; Trapezoid; Parallelogram; Rectangle; Square; Rhomboid; Rhombus. Ratio and Proportion. Terms; Alternation; Inversion; Composition and Division. The Circle; Theorems; Area; Circumference, etc.

SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons; Rectangles, Parallelograms, etc.

PROBLEMS OF CONSTRUCTION: Twenty-nine problems in Construction of Plane Figures.

TRIGONOMETRY AND LOGARITHMS

TRIGONOMETRY: Definitions; Functions of Acute Angles; Measurement of Angles; Complementary Functions. Fundamental Theorems; Theorems Connecting the Different Functions of an Angle.

FUNCTIONS: From One Function of an Angle to Find the Other Functions. Functions of 45 degrees, 30 degrees and 60 degrees. Trigonometric Functions of Any Angle, Positive and Negative Angles; The Four Quadrants. Functions of 0 degrees, 90 degrees, 180 degrees and 270 degrees. Angles and Triangles.

LOGARITHMS: Nature and Use of Logarithms; Logarithms of a Product, a Fraction, a Power, a Root. Solutions of Arithmetical Problems by Logarithms.

TRIANGLES: Right Triangles: Solution by Natural Functions; Solutions by Logarithms; Areas. Oblique Triangles: Solution by Breaking up into Right Triangles; Areas.

EXERCISES: Length of Belt over two Pulleys; Stress in Rods forming an Acute Angle.

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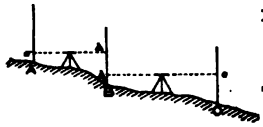
PLANE SURVEYING

MEASUREMENTS: Tapes; Chain; Accessible and Inaccessible Points; Sags and Directions; Chaining; Slope Measurements; Areas; Perpendiculars; Erect and Fall from a Given Line; Parallel Measurements to a Given Point; Prolonging Beyond Obstacles; Surveying Fields; Areas; Offsets and Tie-Lines. Inaccessible Areas; Valleys and Hills; Keeping Field Notes: By sketches Alone; By Notes Alone; By Notes and Sketches. Vernier: Direct; Retrograde; Construction; Use.



LEVELING: Level Bubble; Hand Level; Abney Clinometer; Field Notes; Height and Elevation. Levels; Wye; Dumpy; Precise; Spirit. Adjustments; Uses. Rods: Kinds; Use; Method of Reading.

TRANSIT: Makes; Purpose; Use; Adjustments; Construction; Compass. Triangulation: Method; Preliminary Object; Field Notes; Stadia: Height; Instruments; Method; Different Rods.

PLOTTING AND TOPOGRAPHY

DEFINITIONS: Contours; Telemetry; Office Work; Reduction of Observations; Plotting of Profiles; Plotting of Stadia Survey Notes; Plotting of Maps by Projection; Three-point Problem: Topographical Signs; Lettering and Border Line.

DRAWING INSTRUMENTS: Three-armed Protractor; Pantograph; Stadia Slide Rule; Polar Planimeter; Stadia Reduction Table; Table of Dimensions and Co-ordinates for Map Construction.

HYDRAULICS

A special course in Hydraulics and Water Supply for City Engineers and those engaged in the Design, Construction and Management of Hydraulic Machinery.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Plane Surveying Part I.
Plane Surveying Part II.
Plane Surveying Part III.
Plotting and Topography.
Masonry Construction Part I.
Masonry Construction Part II.
Hydraulics.
Water Supply Part I.
Water Supply Part II.

Tuition $55.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers; Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

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RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

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ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

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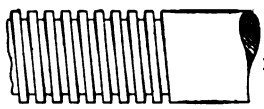
PROPERTIES OF MATTER: Atoms and Molecules; Solids; Liquids; Gases; Extensibility; Impenetrability; Indestructibility; Inertia; Divisibility; Porosity; Hardness; Tenacity; Brittleness; Malleability; Ductility.



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PNEUMATICS: Barometers; Mariotte's Law; Suction Pumps.

ALGEBRA

EXPRESSIONS: Symbols; Coefficients and Exponents; Symbols of Relation; Symbols of Abbreviation; Positive and Negative Terms; Monomial; Binomial; Trinomial; Polynomials; Similar Terms. Finding Numerical Value by Substitution. Finding Values of Unknown Quantities.

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DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse Complementary; Supplementary; etc. Parallel Lines; Axioms.

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TRIANGLES: Right Triangles: Solution by Natural Functions; Solutions by Logarithms; Areas. Oblique Triangles: Solution by Breaking up into Right Triangles; Areas.

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MEASUREMENTS: Tapes; Chain; Accessible and Inaccessible Points; Sags and Directions; Chaining; Slope Measurements; Areas; Perpendiculars; Erect and Fall from a Given Line; Parallel Measurements to a Given Point; Prolonging Beyond Obstacles; Surveying Fields; Areas; Offsets and Tie-Lines. Inaccessible Areas; Valleys and Hills; Keeping Field Notes: By Sketches Alone; By Notes Alone; By Notes and Sketches. Vernier: Direct; Retrograde; Construction; Use.

LEVELING: Level Bubble; Hand Level; Abney Clinometer; Field Notes; Height and Elevation. Levels: Wye; Dumpy; Precise; Spirit. Adjustments; Uses. Rods: Kinds; Use; Method of Reading.

TRANSIT: Makes; Purpose; Use; Adjustments; Construction; Compass. Triangulation: Method; Preliminary Object; Field Notes; Stadia: Height; Instruments; Method; Different Rods.

PLOTTING AND TOPOGRAPHY

GENERAL TERMS AND DEFINITIONS: Object; Instruments; Preliminary Surveys; Purpose; Duties of Topographer; Method of Sketching. Keeping of Field Notes; Plotting of Field Notes; Small Scale; Large Scale; Contours; Valleys; Streams; Woods; Springs; etc. Vertical and Horizontal Distance. Method of Locating Contours: Computing Right of Way Areas: Locating Buildings; Improvements: Stadia Measurements.

MASONRY CONSTRUCTION

CLASSES OF MASONRY: First and Second Class; Arch Culverts; Centering; Wing Walls; Pointing; Grouting; Freezing; Brick Masonry; Dry Walls; Dry Box Culverts; Pipe Culverts.

FOUNDATIONS: Excavation; Artificial Foundations; Timber; Piles; Cofferdam; Iron; Blast Furnace Slag; Concrete: Mixing; Compressive Strength; Period of Repose.

CEMENT: Hydraulic; Natural; Portland; Characteristics of Portland Cement; Cement Test; Effect of Age; Quick and Slow Set Cement. Soundness; Fitness; Specifications.

MORTAR: Sand; Water; Strength of Mortar; Shearing; Compressive and Tensile Strength; Effect of Frost; Permanency; Data; Specifications.

HYDRAULICS

HYDROSTATICS: Head; Pressure; Center of Pressure; Pressures on Opposite Sides of a Plane; Loss of Weight in Water; Flotation.

HYDRAULICS: Velocity and Discharge; Velocity of Approach; Pressure Head; Velocity Head; Energy of a Jet; Impulse and Reaction; Orifices: Coefficients; The Miner's inch; Submerged Orifices; Measurement of Water by Orifices; Energy of Discharge; Canal Lock: Weirs: Hook Gauge; Francis' Formulas; Waste Weirs and Dams; Tubes; Nozzles, and Jets; Effective and Lost Head; Water Meter.

PIPES: Losses of Head; Discharge; Short and Long Pipes; Hydraulic Gradient; Nozzle; House-Service Pipes; Mains and Branches; Pumping through Pipes; Fire Hose; Flow in Conduits and Canals; Conduits; Bazin's Formula; Sewers, Ditches and Canals; Loss of Head; Energy of Flow.

WATER POWER: Measurements; Test of Small Motor; Pressure of Flowing Water; Impulse and Reaction; Curved Pipes and Channels; Water Wheels; Conditions of High Efficiency; Kinds of Wheels; Turbines; The Reaction Wheel; Theory; Design; Guides and Vanes.

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WATER SUPPLY

SOURCES: Consumption per Capita; Fire Demands; Surface Water; Lakes and Rivers; Rainfall; Ground Water; Artesian Supplies. Quality of Ground Waters.

CONSTRUCTION OF WORKS: River and Lake Intakes; Wells and Galleries; Impounding Reservoirs: Capacity; Location; Construction; Dams; Conduits and Pipe Lines. Canals. Distributing Systems; Reservoirs; Stand Pipes and Tanks. Pressure; Fire Streams; Hydrants; Service Connections; Details. Pumping Station Machinery. Operation and Maintenance: Water Rates; Use of Meters.

PURIFICATION OF WATER: Sedimentation; Filtration; Various Forms of Filters; Other Methods of Purification.

STRUCTURAL DRAFTING

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Freehand Drawing.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Perspective Drawing.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Strength of Materials Part I.
Strength of Materials Part II.
Statics.
Steel Construction Part I.
Steel Construction Part II.
Steel Construction Part III.
Steel Construction Part IV.
Bridge Design.

Tuition $55.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight: Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

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MECHANICS

PROPERTIES OF MATTER: Atoms and Molecules; Solids; Liquids; Gases; Extensibility; Impenetrability; Indestructibility; Inertia; Divisibility; Porosity; Hardness; Tenacity; Brittleness; Malleability; Ductility.

MOTION, VELOCITY AND FORCE: Momentum; Newton's Laws; Parallelgram of Forces; Force Diagrams. Center of Gravity; Falling Bodies; Projectiles; The Pendulum; Kinetic and Potential Energy; Centrifugal Force.

PRINCIPLES OF MACHINES: Levers; Pulleys; Inclined Planes; Wedges; Screws; Laws of Friction; Coefficients of Friction. Tooth Gears: Spur; Worm; Bevel; Helical; Belt. Wire and Rope Gearing. Velocity Ratio; Horse Power Transmitted.

STRENGTH OF MATERIALS: Cohesion; Adhesion; Capillarity; Stress; Deformation; Elastic Limit; Breaking Strength; Coefficient of Elasticity; Tension; Compression; Shear; Torsion; Factor of Safety; Working Stress. Strength of Pipes and Cylinders; Strength of Beams and Columns; Moment of Inertia; Diagrams and Formulas.

HYDROSTATICS: Density; Specific Gravity; Hydrometers; Pressure of Fluids; Hydraulic Press; Head; Pressure Dams and Gates; Coefficients of Flow; Water Motors; Turbines.

PNEUMATICS: Barometers; Mariotte's Law; Suction Pumps;

MECHANICAL DRAWING

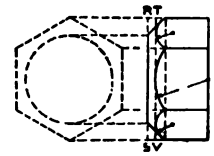
INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises in Line Work.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids; Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric; Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.

LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads. Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for Solutions for Blue-Print Paper. Plates.



ALGEBRA

EXPRESSIONS: Symbols; Coefficients and Exponents; Symbols of Relation; Symbols of Abbreviation; Positive and Negative Terms; Monomial; Binomial; Trinomial; Polynomials; Similar Terms. Finding Numerical Value by Substitution. Finding Values of Unknown Quantities.

FUNDAMENTAL PROCESSES: Addition; Subtraction; Use of Parentheses; Multiplication; Division; Formulae; Factoring; Highest Common Factor; Lowest Common Multiple.

FRACTIONS: Fractions and Integers; Reduction of Fractions to Lowest Terms; Reduction of Fractions to Entire or Mixed Quantities; Reduction of Mixed Quantities to Fractions; Reduction of Fractions to Lowest Common Denominator; Addition and Subtraction of Fractions; Multiplication and Division of Fractions; Complex Fractions.

SIMPLE EQUATIONS: Transposition; Solution of Simple Equations; Solution of Equations Containing Fractions; Literal Equations; Equations involving Decimals; Equations Containing Two Unknown Quantities: Elimination by Addition, Subtraction, Substitution and Comparison.

INVOLUTION AND EVOLUTION: Monomials and Polynomials; Squares, Cubes and Higher Powers. The Radical Sign; Theory of Exponents; Radicals; Reduction of Radicals to Simplest Form; Addition; Subtraction, Multiplication and Division of Radicals. Involution and Evolution of Radicals. Irrational Denominators; Approximate Values.

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IMAGINARY QUANTITIES: Multiplication and Division of Imaginary Quantities. Quadratic Surds.

EQUATIONS: Solution of Equations Containing Radicals. Pure and Affected Quadratic Equations; Simultaneous Equations Involving Quadratics.

RATIO AND PROPORTION: Alternation; Inversion; Composition; Division.

PROGRESSION: Arithmetical and Geometrical.

BINOMIAL THEOREM: Formulae; Positive Integers; Finding Terms in an Expansion.

GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse Complementary; Supplementary; etc. Parallel Lines; Axioms.

FUNDAMENTAL THEOREMS: Plane Figures; Polygons: Equilateral and Equiangular. Quadrilaterals; Circles; Measurements of Angles; Similar Figures; Trapezium; Trapezoid; Parallelogram; Rectangle; Square; Rhomboid; Rhombus. Ratio and Proportion. Terms: Alternation; Inversion; Composition and Division. The Circle: Theorems; Area; Circumference, etc.

SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons: Rectangles, Parallelograms, etc.

PROBLEMS OF CONSTRUCTION: Twenty-nine problems in Construction of Plane Figures.

TRIGONOMETRY AND LOGARITHMS

TRIGONOMETRY: Definitions; Functions of Acute Angles; Measurement of Angles; Complementary Functions. Fundamental Theorems; Theorems Connecting the Different Functions of an Angle.

FUNCTIONS: From One Function of an Angle to Find the other Functions of any Angle. of 45 degrees, 30 degrees and 60 degrees. Trigonometric Functions of Any Angle. Positive and Negative Angles; The Four Quadrants. Functions of 0 degrees, 90 degrees, 180 degrees and 270 degrees. Angles and Triangles.

LOGARITHMS: Nature and Use of Logarithms; Logarithms of a Product, a Fraction, a Power, a Roof. Solutions of Arithmetical Problems by Logarithms.

TRIANGLES: Right Triangles: Solution by Natural Functions; Solutions by Logarithms; Areas. Oblique Triangles: Solution by Breaking up into Right Triangles; Areas.

EXERCISES: Length of Belt over two Pulleys; Stress in Rods forming an Acute Angle.

STRENGTH OF MATERIALS

RESISTANCE AND ELASTICITY: Average Weights; Stresses and Deformations. Experimental Laws; Tension; Compression; Shear; Factors of Safety and Working Stresses.

BEAMS: Cantilever and Simple Beams; Reactions of Supports; Vertical Shear; Bending Moments; Internal Stress and External Forces; Fundamental Formulas; Moments of Inertia; Center of Gravity; Maximum Bending Moment; Safe Loads; Designing; Modulus of Rupture; Comparative Strength; Iron and Steel I-Beams: Cast-Iron Beams; Deflection; Relation between Deflection and Stress. Beams of Uniform Strength. Continuous Beams.

COLUMNS: Cross-sections; General Principles; Radius of Gyration; Designing. Torsion; Shafts for Transmitting Power. Combined Stresses; Horizontal Shear.

TESTING: Timber; Brick; Cement; Mortar; Stone; Cast Iron; Wrought Iron; Steel. Resilience: Sudden Loads and Impact; Modulus; Elastic Resilience of Beams; Ultimate Resilience; Modern Experiments.

TENSION AND COMPRESSION: Elongation under own Weight; Bar of Uniform Strength; Longitudinal Impact; Centrifugal Stress; Shrinkage of Hoops.

SHEAR AND TORSION: Stresses Caused by Shear; Resilience under Shear; Coefficients of Elasticity: Hollow and Solid Shafts; Shaft Couplings.

GRAPHIC STATICS

PRINCIPLES AND METHODS: Force Triangle; Force Polygon; Conditions of Equilibrium; Stresses in Crane Truss; Stresses in Polygonal Frame; Properties of the Equilibrium Polygon; Reactions of Beams; Simple Beams under Concentrated Loads; Under Uniform Loads; Overhanging Beams; Center of Gravity and Moment of Inertia of Cross-Sections; Graphical Arithmetic.

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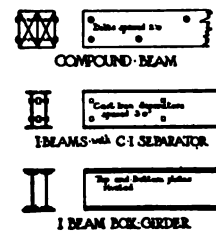
ROOF TRUSSES: Dead and Snow Loads; Stresses Due to Loads. Triangular Roof Truss; Wind Loads; Truss with Fixed Ends; Truss with One End Free; Abbreviated Methods for Wind Stress; Complete Stresses for a Triangular Truss; Crescent; Ambiguous Cases; Unsymmetrical Loads and Trusses.

BRIDGE TRUSSES: Loads on Bridge Trusses; Dead Load Stresses. Live Load Stresses in a Warren Truss; In a Pratt. Snow-Load Stresses. Wind Stresses; Stresses; Due to Initial Tension; Final Maximum and Minimum Stresses; Bowstring Truss; Application; Equilibrium Polygon; Excess Loads; Analysis Plate Girder; Analysis Pratt Truss; Double Quadruple Systems.

ANALYTICS

STRESSES IN ROOF TRUSSES: Loads; Apex; Reactions; External Forces; Internal Stresses; Moments; Lever Arms; Resolution of Forces; Dead-Load Stresses; Snow-Load Stresses; Ends of Roof Trusses; Wind Stresses; Maximum and Minimum Stresses in Roof Trusses; Crescent Roofs; Purlins; Flexure Stresses in Members; Investigation of Roof Trusses; Design of Roof Trusses.

HIGHWAY BRIDGES: Specifications; Live Loads; Dead Loads; Wind Pressure; Length of Span; Limiting Clear Road Ways; Limiting Depth of Punny Trusses; Limiting Slope for Batter Braces of Punny Trusses; Side Braces; Limiting Length of Span for Double Intersection Bridges; Limiting Size of Sections; Anchorage Sliding Continuous Spans; Camber; Vertical Sway Bracing; Struts; Effect of Wind; Initial Tension; Strut Stresses; Working Stresses; Trussing; Batter Bracing Plates; Latticing and Lacing Bars; Pins; Bearings; Chord and Braces; Turn Buckles; Nuts; Washers; Beam Hangers; Jaws; Braces; Test of Structure; Proportion of Main Members of Trusses; Floor System; Pin Proportion; Riveting; Complete Design for a Bridge; Investigation and Design.



RAILROAD BRIDGE TRUSSES: Live and Dead Loads; Wind, Snow and Impact; Trusses, Different Kinds; Warren; Wimple; Bowman and Fink Trusses; Warren Sub-Vertical and Double System; Post Truss; True Live Load Shears; Concentrated Excess Loads. Wheel Loads. Double System; Triple and Quadruple Systems; Unsymmetrical Trusses; Lateral Braces; Economical Depth of Trusses.

BRIDGE DESIGN

HIGHWAY BRIDGE TRUSSES: Definitions; Dead Loads; Kinds of Trusses; Stresses in Web Members; Stresses in Chords; Dead Load Stresses; Live Loads; Stresses and Shears Due to Live Load; Web Stresses in the Warren Truss; Panel Counter-Braces; Web Stresses in Howe and Pratt Trusses; Ranges of Stress; The Bowstring Truss; Parabolic; Other Forms; Snow Load Stresses; Wind. Investigation and Design.

RAILROAD BRIDGE TRUSSES: Dead Loads; Live Loads; Snow, Wind and Impact; Kind of Trusses. True Live Load Shears; One Concentrated Excess Load; Two Concentrated Excess Loads; Locomotive "Wheel" Loads; Shears from Wheel Loads. Tabulation for Locomotive Wheels, Stresses from Locomotive and Train Loads; Remarks on Double Systems; Example of a Double System Truss; Triple and Quadruple Systems; Unsymmetrical Trusses; Lateral Bracing; Economic Depth of Trusses.

STEEL CONSTRUCTION

STRUCTURAL ELEMENTS OF A BUILDING: The Enclosing Walls; Interior Columns and Bearing Partitions; The Floors; The Roof; Use of Handbooks on Steel; Tables; Building Laws and Specifications; The Steel Frame; Fireproof and Fire-resting Materials; Floor and Roof Arches; Selection of System; Partitions; Fire-resisting Wood; Beams and Girders; Determination of Load; Distribution of Load; Beam Plates.

COLUMNS: Shapes used; Calculation of Sections; Cast Iron Columns; Concrete and Steel Columns; Trusses; Selection; Bracing.

CONNECTIONS AND DETAILS OF FRAMING: Column Caps, Bases and Splices; Roof Details; Inspection; Drawings and Specifications; Shop Practice; Standard Frames; Invoices; Estimating; Foundations; High Building Construction; Wind Pressures; Mill Building Construction; Detailing; Riveting; Standard Connections; Details from Framing Plan; Column Details; Shaft Details; Functions of Flanges and Webs; Proportioning Flanges; Depth of Webs; Use of Stiffeners; Cutting off Flange Plates; Spacing of Flange Rivets; Flange Splices; Shop Details of Girders; Standard in Detailing Trusses; Special Notes and Details; Direction of Stress; Stress in Verticals; Stress in Diagonals; Choosing the Section; Use of Gussets; Trussed Stringers.

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Class Room, American School of Correspondence in Australasia

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DEPARTMENT OF

SANITARY ENGINEERING

COURSES

HEATING, VENTILATING AND PLUMBING

HEATING AND VENTILATION

PLUMBING AND GAS FITTING

SANITARY ENGINEERING

THE heating of buildings is successfully accomplished by applying the general physical laws of heat to the construction of the apparatus. This is especially true of large buildings which require the skill of the best engineers as regards both design and construction. The thousands engaged in the design, installation and operation of heating systems recognize the necessity of a thorough knowledge of these laws and principles. The aim of these courses is first to explain these general principles and then the methods of applying them. The student also becomes familiar with important constructive details as well as the principles of design. Without such knowledge one cannot form an intelligent opinion of the relative merits of the various systems and the classes of buildings to which a given system is best adapted. Some of the more important special systems of heating here explained are of great interest. One of the objects of the instruction on Heating and Ventilation is to aid architects in their work. The numerous tables compiled from actual experience make the calculations much easier.

The problems relating to domestic water supply, the disposal of sewage and the installation of gas-lighting systems are explained in the instruction papers on Plumbing. Well chosen illustrative examples explain clearly the calculations for the sizes of heaters, tanks, etc., for hot-water supply. The methods of disposing of sewage are carefully outlined and compared; the constructive details and the design, however, belong to Civil Engineering and are therefore taken up in the courses of that department.

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HEATING, VENTILATING AND PLUMBING

INCLUDING MECHANICAL DRAWING

Prepared for Heating and Ventilating Engineers, Plumbers, Architects, Steam Engineers, Firemen, Janitors, Consulting Engineers, Designers, Draftsmen, Inspectors, Contractors and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanics Part I.
Mechanics Part II.
Mechanism.
Heat.
Elements of Chemistry.
Metallurgy.
Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Steam Pumps.
Steam Engine Part I.
Indicators.
Valve Gears.
Steam Engine Part II.
Heating and Ventilation Part I.
Heating and Ventilation Part II.
Heating and Ventilation Part III.
Steam and Hot Water Fitting.
Plumbing Part I.
Plumbing Part II.
*Algebra Part I.
*Algebra Part II.
*Geometry.
*Trigonometry and Logarithms.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.

The Diploma is awarded on completion of the above Examination Papers. The Graduate may take either one of the following groups of options. For Synopsis see pages 31, 45 and 46.

ELECTRICAL

Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Electric Wiring.
Electric Lighting.

MECHANICAL

Machine Design Part I.
Machine Design Part II.
Pattern Making Part I.
Pattern Making Part II.
Foundry Work.
Forging.
Machine Shop Work Part I.
Machine Shop Work Part II.
Machine Shop Work Part III.

Tuition $50.00. Payable Monthly.

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*Optional.

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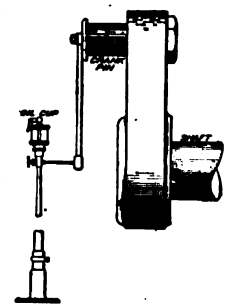
SYNOPSIS OF COURSE

GENERAL STUDIES

ARITHMETIC, ELEMENTARY ALGEBRA AND MENSURATION, MECHANICS, MECHANISM, HEAT, ELEMENTS OF CHEMISTRY, METALLURGY SEE SYNOPSIS PAGE 166

STEAM BOILERS

CONSTRUCTION OF BOILERS. Materials; Testing; Punching; Drilling; Riveting; Joints; Arrangement of Plates; Staying; Expanding Tubes; Furnace Flues; Calking; General Requirements; Grate Area; Steam and Water Spaces; Heating Surface; Formulas for Thickness and Allowable Pressure; Riveted Joints; Flues, Tubes and Stays; Manholes; Brackets; Uptake; Chimney.



TYPES OF BOILERS. Cornish; Lancashire; Galloway; Multitubular; Vertical Boilers; Manning; Fire Engine; etc. Water Tube Boilers: Babcock & Wilcox; Root; Heine; Almy; Cahall; Belleville; Yarrow; Thornycroft; Field. Marine and Locomotive Boilers.

BOILER ACCESSORIES. Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels:. Coal; Coke; Wood; Composition and Heat Value of Fuels. Care of Boilers: Feed Water; Firing; Cleaning; Inspection; Testing.

STEAM ENGINES

PUMPS: Principles, Kinds; Valves; Design and Construction; Capacity; Sizes for Boiler Feed; Erection and Piping; Care; Speed; Representative Types.

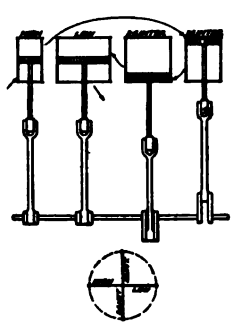
PARTS OF STEAM ENGINE: Cylinder; Piston; Crank; Crosshead; Valve; Eccentric.

TYPES: Simple; Compound; Triple Expansion; High Speed; Pumping.

ACCESSORIES: Condensers; Cooling Towers; Fly Wheel; Governors; Lubrication.

STEAM TURBINE: De Laval; Parsons. Advantages over Reciprocating type.

INDICATORS: Indicator Diagrams; Mean Effective Pressure; Watts Diagram; Watts Indicator; Crosby, Thompson and Tabor Indicators. Reducing Motions. Calculation of Horse Power from Diagrams; Table of Steam Engine Constants; Measuring Card by Ordinates and by Planimeter.



DIAGRAMS: Ideal Cards; Actual Cards; Cards for Multi-Expansion Engines; Faults of Indicator Cards; Remedies. Calculation of Steam Consumption from Indicator Cards.

THE SLIDE VALVE: Operation; Ports; Eccentric; Valve Diagrams; Zenner Diagram; Designing the Slide Valve. Calculations. Setting: Equal Lead; Equal Cut Off. Reversing Gear: Stephenson; Gooch. Allen and Joy Gears. Piston; Double Ported; Trick; Double Gears; Corliss; Methods of Balancing.

ACTION OF HEAT: Gases; Boyle's Law; Saturated and Superheated Vapor; Efficiency of Actual Engine; Losses; Initial Condensation. Devices for Economy: Lagging; Jacketing; Superheating; Condensing; Measurement of Vacuum; Compounding; Corliss Valves; Separators. Piston Speed; Ratio of Expansion.

WORK DONE IN CYLINDER: Indicator; Formulas; Crank Action; Turning Moment. Testing: Scales; Meters; Gages; Calorimeter; Brake; Log of Test.

HEATING AND VENTILATION

HEATING AND VENTILATION: Stoves; Furnaces; Steam; Hot Water; Exhaust Steam; Forced Blast; Electricity. Ventilation: Composition of the Atmosphere; Carbonic Acid; Measurement of Velocity; Location of Inlets and Outlets; General Considerations. Heat Loss from Buildings: B. T. U. Causes of Loss; Calculations and Tables.

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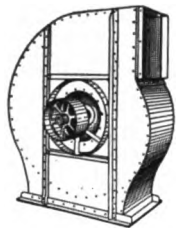
FURNACE HEATING: Furnaces; Location; Parts; Direct and Indirect Draft; Cold-Air Box; Pipes, Ducts and Registers. Care and Management.



STEAM HEATING: Radiators; Location; Systems of Piping; Wet and Dry Return; Connections; Valves; Pipe Sizes. Indirect Steam Heating: Heaters; Stacks and Casings; Dampers; Flues and Ducts; Wall Box and Netting. General Instructions for Care of Systems.

HOT-WATER HEATING. Radiating Surface; Heaters; Piping; Expansion Tank; Overhead Distribution; Valves and Fittings; Pipe Sizes; Location of Radiators. Indirect Hot-Water Heating: Sizes of Heaters; Pipe Connections and Sizes; Care of Hot Water Heaters.

EXHAUST-STEAM HEATING: Reducing Valves; Grease Extractor; Exhaust Head; Pumps and Traps; Paul System; Plenum Method; Efficiency of Heaters; Fans and Blowers; Engines; Factory Heating; Double-Duct Systems. Temperature Regulators.

VENTILATION OF BUILDINGS: Choice of Systems, Calculations, and Hints for Heating and Ventilating School Houses, Theatres, Apartment Houses, Greenhouses, Factories, etc.

STEAM FITTING: Supply of Pipe; Cutting Pipe; Tools; Making and Packing Joints; Flange Unions.

STEAM AND HOT WATER FITTING

STEAM BOILERS AND CONNECTIONS: Cast Iron Boilers; Arrangement of Grates; Selection of Boilers; Boiler Settings and Foundations; Boiler Connections; Boiler Fittings; Capacity; Coal Consumption; Non-conducting Coverings.

STEAM RADIATORS AND COILS: Direct Radiators; Concealed Radiators; Wall Coils; Miter Coils; Direct-Indirect Radiators; Indirect Radiators.

STEAM PIPING: Size of Mains; Dry Return Systems; Wet Return Systems; Overhead Feed System; One-pipe System; Two-pipe System; Draining Mains and Risers; Pipe Sizes; Steam Pressures and Temperatures; Expansion of Pipe; Expansion of Risers; Radiator Connections; Computing Radiation; Ducts, Flues and Registers.

EXHAUST STEAM HEATING: Modified Systems of Steam Heating; Thermo-grade System; Vapor System; Mercury Seal Vacuum System.

PIPES AND FITTINGS: Tees; Hangers; Sleeves; Valves; Air Vulves.

PIPE FITTING TOOLS: Vice; Bench; Die Cutters; Stocks and Dies; Pipe Tongs; Wrenches; Pliers; Drills; Reamers; Taps.

HOT WATER HEATING: Capacity of Heaters; Radiators and Valves.

HOT WATER PIPING: Single Main System; Two-pipe Up-feed System; Return Mains; Risers; Overhead Feed Systems; Radiator Connections; Expansion Tank Connections; Capacity of Expansion Tanks.

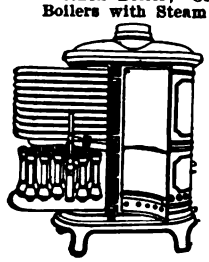
COMPUTING RADIATION: Area of Ducts and Flues; Heating of Water.

PLUMBING

FIXTURES: Bath Tubs; Water Closets; Urinals; Lavatories; Bowls; Sinks; Traps; Faucets; Soil and Waste Pipes; Connections. Traps and Vents; Fresh-Air Inlets; Sewers and Cesspools.

PLUMBING FOR VARIOUS BUILDINGS: Bath Room: Location and Connections; Kitchen Sink Connections; Plumbing Dwelling Houses; Apartment Houses; Railroad Stations; School Houses; Shops and Factories. Testing and Inspection: Ether, Peppermint, and Smoke Tests.

DOMESTIC WATER SUPPLY: Friction in Pipes; Pipe Lining; Pumps; Hydraulic Ram; Kitchen Boiler; Coils; Water-Back Connections; Circulation Pipes; Laundry Boilers; Boilers with Steam Coils; Temperature Regulators.



SEWAGE: Systems; Considerations Governing Choice. Design and Construction of Sewers: Topography; Manholes; Grades; Flushing; House Connections; Ventilation; Catch Basins; Pumping Stations. Purification: Sedimentation; Chemical Precipitation; Irrigation; Intermittent Filtration.

GAS FITTING: Pipes; Meters; Fittings; Joints; Risers; Location of Pipes; Pipe Sizes; Testing Gas Pipes. Gas Fixtures: Burners: Batswing; Fishtail; Bunsen; Argand; etc. Chandeliers, Globes and Shades. Heating and Cooking by Gas. Automatic Hot-Water Heaters. Gas Meters: Position; Dials; Reading. Gas Machines.

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MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

MECHANICAL DRAWING

SEE SYNOPSIS PAGE 168

HEATING AND VENTILATION

A short, practical course for Heating and Ventilating Engineers, Steam Fitters, Architects, Contractors, Builders, Stationary and Consulting Engineers, Draftsmen, Students and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Heat.
Elements of Chemistry.
Boiler Accessories.
Steam Pumps.
Steam Engine Part I.
Heating and Ventilation Part I.
Heating and Ventilation Part II.
Heating and Ventilation Part III.
Steam and Hot Water Fitting.

Tuition $25.00. Payable Monthly.

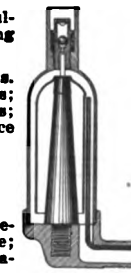
SYNOPSIS OF COURSE

MATHEMATICS

ARITHMETIC: Units; Numbers; Notation; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation; Fractions; Decimals; Symbols of Aggregation; Percentage; Denominate Numbers; Tables of Linear and Square Measure; Tables of Weights; Involution; Evolution; Square Root; Cube Root; Roots of Fractions; Ratio; Proportion.

ELEMENTARY ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division; Cancellation; Equations; Transportation; Finding Value of Unknown Quantities.

MENSURATION: Lines; Angles; Polygons; Circles; Sectors and Segments. Measurement of Angles; Triangles; Rectangles; Trapezoids; Hexagons; Circles; Volumes and Surfaces of Prisms; Cylinders; Pyramids; Cones; Frustums; Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.



HEAT

DEFINITION AND NOTATION: Definition of Heat; Amount of Heat; Degree of Heat; Thermometer: Temperature; Fahrenheit; Centigrade; Reaumur. Freezing and Boiling Points. Notation: Absolute Temperature; Changing from one Scale to another.

HEAT EFFECTS: Expansion: Cubical; Linear; Coefficients of Expansion; Expansion of Solids, Liquids and Gases. Liquefaction: Laws of Fusion; Table of Melting Points; Vaporization; Evaporation; Boiling; Table of Boiling Points; Boiling under Pressure and in Vacuum. Distillation; Conduction; Convection; Radiation.

THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

PRACTICAL APPLICATIONS: The Steam Engine and Hot-Air Engine; Manufacture of Ice; Production of Liquid Air.

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ELEMENTS OF CHEMISTRY

FUNDAMENTAL PRINCIPLES: Physical and Chemical Changes; Mechanical Mixture; Molecules and Atoms.

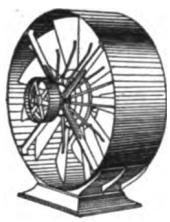
ELEMENTS: Table of Elements with Symbols, etc. Atomic Weight; Vapor Density; Law of Definite Weight; Valence; Combining Value. Equations, Factors and Products.

PROPERTIES: Physical and Chemical Properties of Oxygen; Hydrogen; Nitrogen, Chemistry of Air and Water; Carbon: Forms and Compounds. Illuminating Gas; Water Gas; Coal Gas; Composition. Combustion: Carbon Monoxide; Carbon Dioxide.

METALS: Sodium: Properties; Compounds. Calcium: Properties; Compounds.

ACIDS: Manufacture of Sulphuric, Nitric, and Hydrochloric Acids.

STEAM



BOILER ACCESSORIES: Furnaces; Grate; Smoke Prevention; Mechanical Stokers; Fuel Economizers; Natural and Forced Draft. Valves: Globe; Gate; Check; Safety. Blow Out Apparatus; Gage Cocks; Gage Glasses; Pressure Gages; Fusible Plugs; Separators; Traps; Supports; Manholes; Pipes; Pumps; Heaters; Injectors; Horse Power; Factors of Evaporation; Corrosion and Incrustation; Explosions. Fuels. Care of Boilers.

PUMPS: Principles; Suction; Forcing; Jet; Rotary; Double Acting; Lift; Plunger; Geared; Duplex; Compound; Centrifugal. Valves; Arrangement of Parts; Capacity; Proportions; Sizes for Boiler Feed; Piping; Foundation; Packing; Lubrication; Speed; Running; Principal Types.

PARTS OF STEAM ENGINE: Cylinder; Piston; Crank Crosshead; Valve; Eccentric. Types; Simple; Compound; Triple Expansion; Quadruple Expansion; High Speed; Pumping Accessories; Condensers; Cooling Towers; Fly Wheels; Governor; Lubrication; Steam Turbine; De Laval; Parsons; Advantages over Reciprocating Type.

HEATING AND VENTILATION

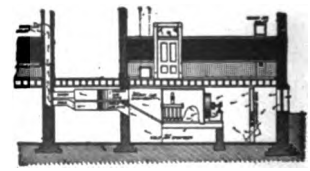
HEATING AND VENTILATION: Requirements of System; Stoves; Furnaces; Steam; Forced Blast; Electricity. Ventilation; Composition of the Atmosphere; Oxygen; Carbonic Acid; Measurement of Velocity; Location of Inlets and Outlets; General Considerations. Heat Loss from Buildings: B. T. U. Causes of Loss; Air Leakage; Calculations and Tables.

FURNACE HEATING: Furnaces; Location; Parts; Direct and Indirect Draft; Efficiency and Heating Capacity; Cold-Air Box; Pipes, Ducts and Registers. Care and Management.

STEAM BOILERS: Types; Attachments; Calculations and Tables.

STEAM HEATING: Types of Radiators; Location; Systems of Piping; Wet and Dry Return; Connections; Valves; Pipe Sizes. Indirect Steam Heating: Heaters; Stacks and Casings; Dampers; Flues and Ducts; Wall Box and Netting. General Instructions for Care of Systems.

HOT-WATER HEATING: Radiating Surface; Heaters; Piping; Expansion Tank; Overhead Distribution; Valves and Fittings; Pipe Sizes; Location of Radiators. Indirect Hot-Water Heating: Sizes of Heaters; Pipe Connections and Sizes; Care of Hot Water Heaters.



EXHAUST-STEAM HEATING: Reducing Valves; Grease Extractor; Exhaust Head; Pumps and Traps; Paul System; Plenum Method; Efficiency of Heaters; Fans and Blowers; Engines; Factory Heating; Double-Duct Systems. Temperature Regulators.

TEMPERATURE REGULATORS: Parts; Distributing Pipes; Thermostats; Pneumatic Valves.

VENTILATION OF BUILDINGS: Choice of Systems, Calculations, and Hints for Heating and Ventilating School Houses; Theatres, Apartment Houses, Greenhouses, Factories, etc.

STEAM FITTING: Supply of Pipe; Cutting Pipe; Tools; Making and Packing Joints.

STEAM AND HOT WATER FITTING

SEE SYNOPSIS PAGE 114

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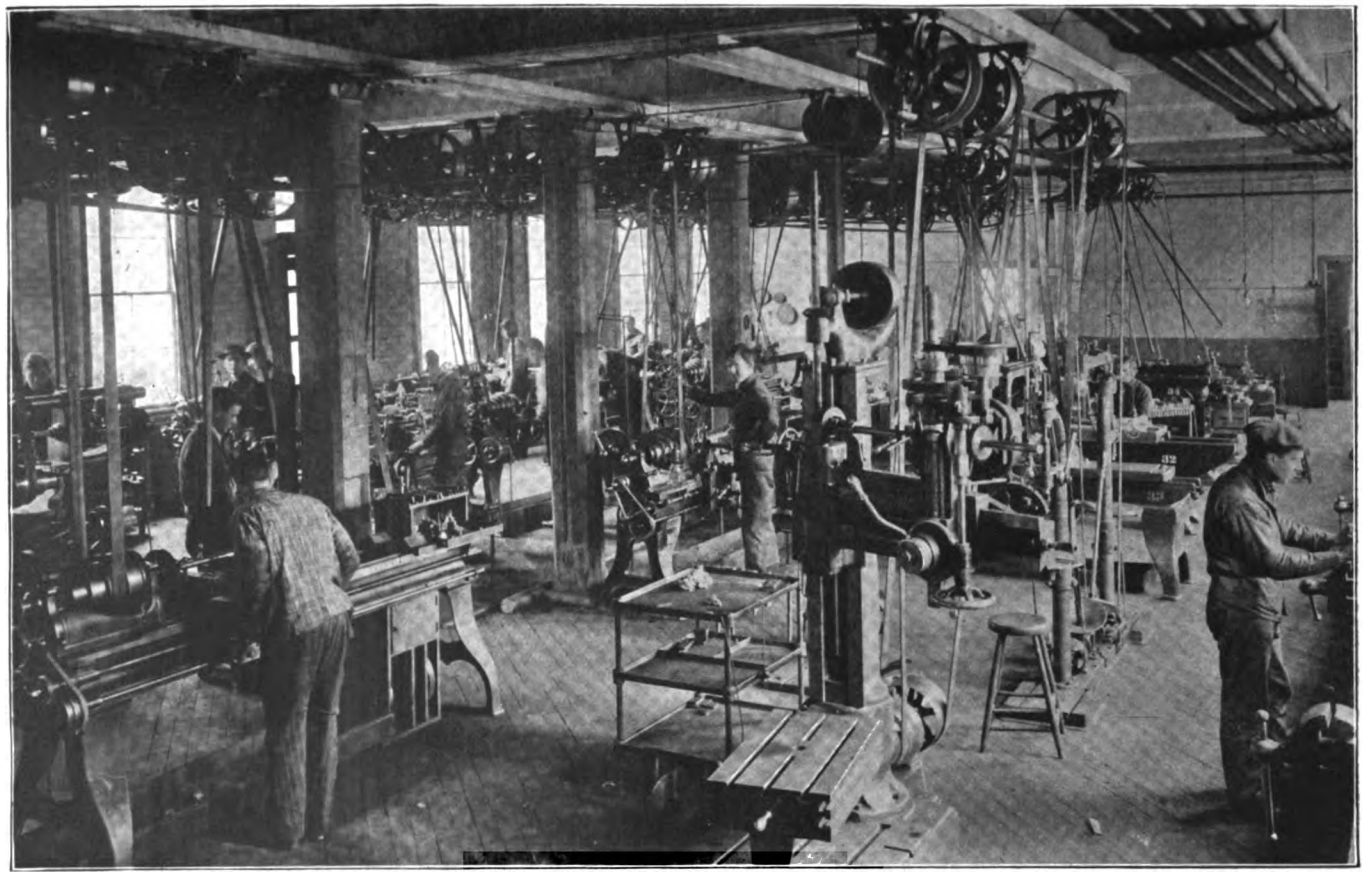

Machine Shop, University of Michigan

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PLUMBING AND GASFITTING

A concise course prepared for Plumbers, Steam and Gas Fitters, Apprentices and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.	Heat.
Arithmetic Part II.	Elements of Chemistry.
Arithmetic Part III.	Plumbing Part I.
Elementary Algebra and Mensuration.	Plumbing Part II.
	Steam and Hot Water Fitting.

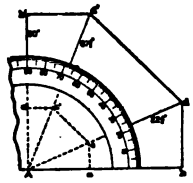
Tuition $25.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction, Multiplication; Division; Factoring; Cancellation.

ARITHMETIC PART II



FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction, Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

ARITHMETIC PART III

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

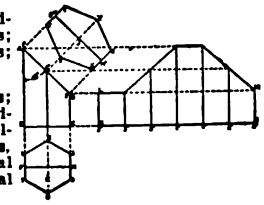
DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight; Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.



MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sector; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

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HEAT

DEFINITION AND NOTATION: Definition of Heat; Amount of Heat; Degree of Heat; Thermometer: Temperature; Fahrenheit; Centigrade; Reaumur. Freezing and Boiling Points. Notation: Absolute Temperature; Changing from one Scale to another.

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THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

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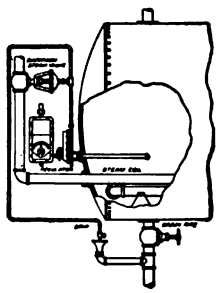
FUNDAMENTAL PRINCIPLES: Physical and Chemical Changes; Mechanical Mixture; Molecules and Atoms.



ELEMENTS: Table of Elements with Symbols, etc. Atomic Weight; Vapor Density; Law of Definite Weight; Valence; Combining Value. Equations, Factors and Products. Saturated Solution.

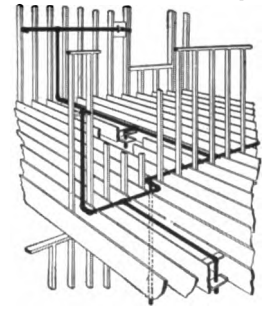
PROPERTIES: Physical and Chemical Properties of Oxygen; Hydrogen; Nitrogen, Chemistry of Air and Water; Carbon: Forms and Compounds. Illuminating Gas; Water Gas; Coal Gas; Composition. Combustion: Carbon Monoxide; Carbon Dioxide.

METALS: Sodium: Properties; Compounds. Calcium; Properties; Compounds.

ACIDS: Manufacture of Sulphuric, Nitric, and Hydrochloric Acids.

PLUMBING

FIXTURES: Bath Tubs; Water Closets; Urinals; Lavatories; Bowls; Sinks; Traps; Faucets; Soil and Waste Pipes; Connections. Traps and Vents; Fresh-Air Inlets; Sewers and Cesspools.



PLUMBING FOR VARIOUS BUILDINGS: Bath Room: Location and Connections; Kitchen Sink Connections; Plumbing Dwelling Houses; Apartment Houses; Railroad Stations; School Houses; Shops and Factories. Testing and Inspection: Ether, Peppermint and Smoke Tests.

DOMESTIC WATER SUPPLY: Friction in Pipes; Pipe Lining; Pumps; Hydraulic Ram; Kitchen Boiler; Coils; Water-Back Connections; Circulation Pipes; Laundry Boilers; Boilers with Steam Coils; Temperature Regulators.

SEWAGE: System; Considerations Governing Choice. Design and Construction of Sewers: Topography; Manholes; Grades; Flushing; House Connections; Ventilation; Catch Basins; Pumping Stations. Purification: Sedimentation; Chemical Precipitation; Irrigation; Intermittent Filtration.

GAS FITTING: Pipes; Meters; Fittings; Joints; Risers; Location of Pipes; Pipe Sizer; Testing Gas Pipes. Gas Fixtures: Burners: Batswing; Fishtail; Bunsen; Argand; etc. Chandeliers, Globes and Shades. Heating and Cooking by Gas. Automatic Hot-Water Heaters. Gas Meters; Position; Dials; Reading. Gas Machines.

STEAM AND HOT WATER FITTING

STEAM BOILERS AND CONNECTIONS: Cast Iron Boilers; Arrangement of Grates; Selection of Boilers; Boiler Settings and Foundations.

STEAM RADIATORS AND COILS: Direct Radiators; Concealed Radiators; Wall Coils; Miter Coils.

STEAM PIPING: Size of Mains; Dry Return Systems; Wet Return Systems; Overhead Feed System; Draining Mains and Risers; Pipe Sizes; Expansion of Pipe; Expansion of Risers; Radiator Connections.

PIPES AND FITTINGS: Tees; Hangers; Sleeves; Valves; Air Valves.

PIPE FITTING TOOLS: Vice; Bench; Die Cutters; Stocks and Dies; Pipe Tongs; Wrenches; Pliers; Reamers; Taps.

HOT WATER PIPING: Single Main System; Two-pipe Up-feed System; Return Mains; Risers.

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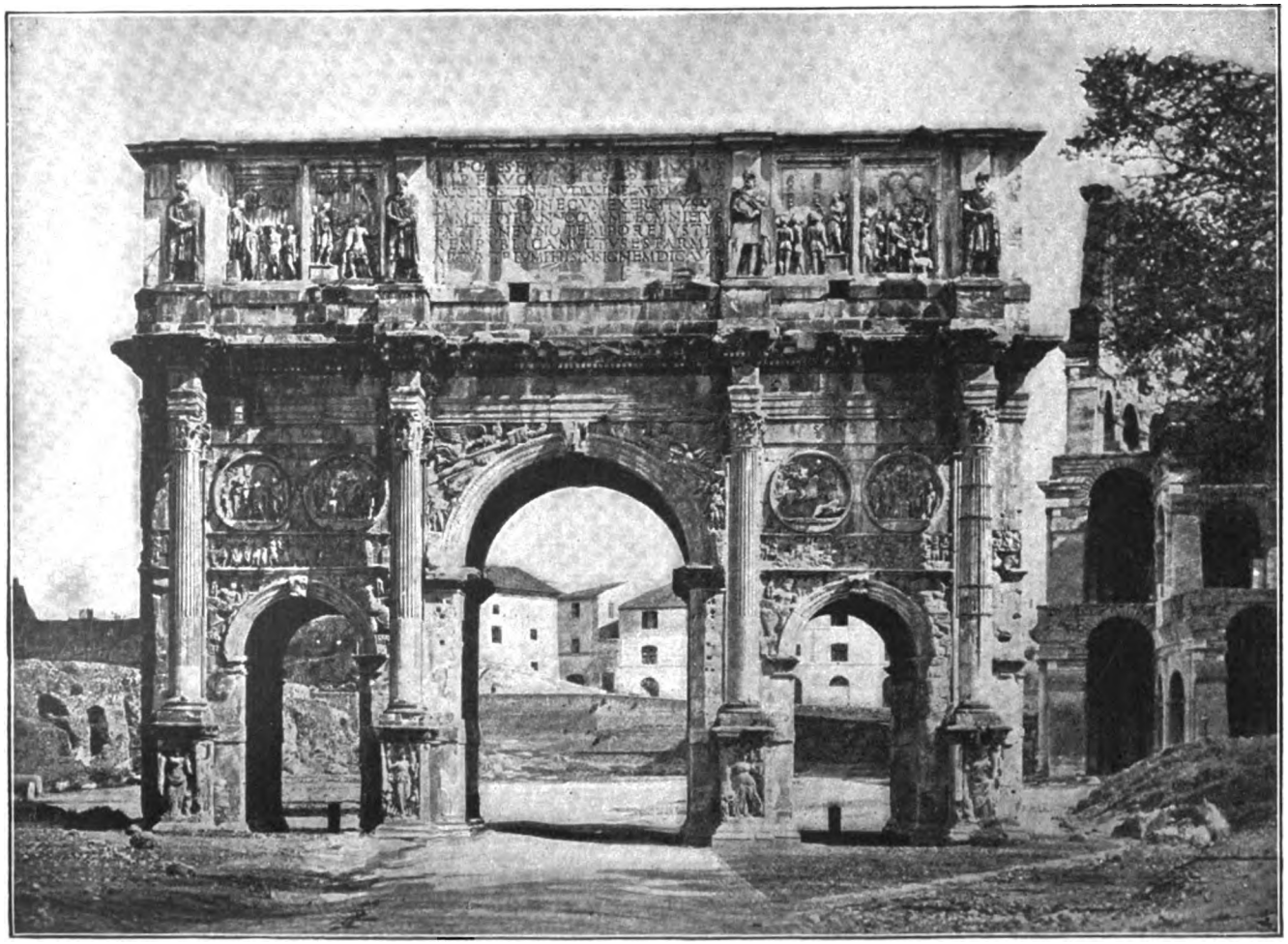

Arch of Constantine. Specimen Plate from Instruction Paper on "Study of the Orders"

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DEPARTMENT OF

ARCHITECTURE

Partial list of the well-known authorities and educators who personally have prepared the instruction papers for correspondence study.

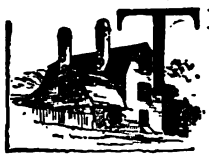
WILLIAM H. LAWRENCE, S. B.,
Professor, Mass. Inst. of Technology.
FRANK A. BOURNE, M. S.,
Fellow, Mass. Inst. of Technology.
EDWARD A. TUCKER, S. B.,
Architectural Engineer.
FRANK CHOUTEAU BROWN,
Author, "Letters and Lettering."
CHARLES L. HUBBARD, S. B., M. E.,
S. Homer Woodbridge Company.
DAVID A. GREGG,
Mass. Institute of Technology.
HERBERT E. EVERETT,
University of Pennsylvania.
GILBERT TOWNSEND, S. B.,
with Post and McCord, New York.
EDWARD NICHOLS,
Architect, Boston.
H. W. GARDINER, S. B.,
Mass. Institute of Technology.

Editors: J. R. COOLIDGE, JR., Architect, Boston. H. V. von HOLST, Architect, Chicago

COURSES

COMPLETE ARCHITECTURE
ARCHITECTURAL ENGINEERING
CONTRACTORS' AND BUILDERS'
ARCHITECTURAL DRAWING
CARPENTERS'

ARCHITECTURE



THE courses in Architecture are planned to cover the actual problems arising in daily work. They offer young men in the architect's office or in the contractor's employ an opportunity to obtain practical information which ordinarily could be acquired only after long apprenticeship. The instruction is of immediate value to carpenters, contractors and others engaged in building, as great stress is laid on the practical as well as the artistic side of the work. The courses offer experienced draftsmen and practicing architects an opportunity to make up deficiencies in their early professional training. The instruction in Heating, Ventilating, Plumbing, Gas Lighting, Wiring,—Electricity and Steam as applied to power and light,—is such as to enable an architect to obtain an intelligent knowledge of subjects which are of growing importance in the planning of large buildings.

The instruction comprises Mechanical Drawing, Descriptive Geometry as used in framing, Isometric and Perspective Drawing, Shades and Shadows, Free-hand Drawing, Pen and Ink Rendering, and the conventional methods of making, figuring, lettering and rendering plans, elevations, sections and details. The student is taught the theory of the design of columns, beams, girders and trusses. Building Materials, Building Construction and Details, including framing, sheet-metal work, fireproofing, wiring, piping,

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heating and ventilating systems, Building Superintendence, Specifications and Contracts, Building Laws and Permits, and general office practice are also discussed.

In connection with Architectural History, instruction is given in History of Ornament, Ornamental Design, followed by a careful study of the fundamental principles of design beginning with the Orders. These principles are impressed upon the student by a series of interesting problems in architectural design.

COMPLETE ARCHITECTURE

Prepared for Draftsmen, Designers, Architects, Architectural Engineers, Landscape Architects, Building Superintendents, Quantity Surveyors, Clerks of Building Works, Inspectors, Contractors and Builders, Masons, Plasterers, Carpenters and Joiners, Heating and Ventilating Engineers, Steam Fitters, Salesmen of Building Materials, Real Estate Agents, Instructors, Students and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Freehand Drawing.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Architectural Lettering.
Shades and Shadows.
Perspective Drawing.
Architectural Drawing Part I.
Architectural Drawing Part II.
Rendering.
Study of the Orders Part I.
Study of the Orders Part II.
Study of the Orders Part III.
History of Architecture.
Building Superintendence Part I.
Building Superintendence Part II.
Strength of Materials Part I.
Strength of Materials Part II.
Masonry Construction Part I.
Masonry Construction Part II.
Carpentry and Joinery Part I.
Carpentry and Joinery Part II.
Stair Building.
Statics.
Steel Construction Part I.
Steel Construction Part II.
Steel Construction Part III.
Steel Construction Part IV.
Contracts and Specifications.
Legal Relations.
Heating and Ventilation Part I.
Heating and Ventilation Part II.
Heating and Ventilation Part III
Plumbing Part I.
Plumbing Part II.

Tuition $80.00. Payable Monthly.

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SYNOPSIS OF THE COURSE

ARITHMETIC

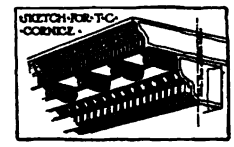
FUNDAMENTAL PROCESSES: Units; Numbers; Concrete and Abstract; Notation; Numeration; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division. **Fractions:** Definitions; Proper and Improper; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction, Multiplication and Division of Fractions. **Decimals:** Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals. **Percentage:** Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight: Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube. **Ratio and Proportion:** Antecedent; Consequent; Extremes and Means; Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.



MENSURATION: Definitions; Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments; Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Shade Lines; Co-ordinates. Isometric of House, etc. Oblique Projection of Crank Arm.

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads. Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for Solutions for Blue-Print Paper.

PERSPECTIVE DRAWING: Station Point; Picture Plane; Ground Line; Horizon; Line of Measures; Axis; Vertical Trace; Horizontal Trace; Bird's-eye View; Worm's-eye View; Vanishing Points. Projections: Planes; Notation. Problems Involving Perspective of Points, Lines and Planes. Revolved Plan; Lines of Measure; Diagrams; Revolved Plan and Elevation; Systems of Lines and Planes; Visual Ray; Perspective Diagram; Method of Perspective Plan; Curves; Apparent Distortion; Choice of Position of Station Point. Plates.

SHADES AND SHADOWS: Principles and Notation; Shadows of Points, Lines and Planes. Co-ordinate Planes; Lines on More Than One Surface. Choosing Ground Line. Problems: Shadows of Prism; Pedestal; Chimney on Roof; Rail on Steps; Cone; Cylinder. Auxiliary Planes; Shadow of Spherical Hollow; Shadow of Scotia. Planes of Light; Shadow of a Sphere; Shadow on Pediment Moulding. Short Methods: Shadows of Points; Lines Parallel and Perpendicular to Co-ordinate Planes. Shadows on Inclined Planes; on Planes Parallel and Perpendicular to Co-ordinate Planes. Shade and Shadow of Cylinder; of Line Moulding; on Intrados of Circular Arch; of Spherical Hollow and Niche; of Sphere; of Torus.

FREEHAND DRAWING: Paper; Pencils; Drawing Board. Difference between a Drawing and a Photograph. Lines and Surfaces. Flat Ornament: Anthemia; Frets; Mosaics; Stained Glass; All Over Patterns. Light and Shade: Value Scale; Point of View; Value Drawing; Point of View of Painter: Geometric Solids. Carved Ornament: Rosettes; Greek Acanthus; Roman Acanthus Scroll; Byzantine Acanthus; Ionic; Corinthian and Gothic Capitals; Renaissance Pilaster.

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RENDERING: Pen and Ink; Kinds of Drawing. Materials Used in Rendering: Pens; Ink; Paper. Examples Showing Common Faults. Values; Lighting; Color of Material; Rendering by Shadows Only. Accent. Pencil Work. Suggestions and Cautions. Examples of Drawings with Criticisms. Wash Drawings; Stretching Paper; Inking the Drawing; Preparing the Tint; Handling the Brush; Laying on the Washes; Tinting Elevations; Tinting Sections and Plans; Graded Tints; Distinction between different Planes. Water-color Hints for Draftsmen: Tube and Pan Colors; List of Colors; Manipulation; Brushes and Paper; Combinations of Color; Primary, Secondary and Complementary Colors; Water-color Rendering; Water-color Sketching.

ARCHITECTURAL LETTERING: Office Lettering; Purpose; Relative Sizes and Shapes of Letters for Titles; Forms and Proportions of Various Alphabets. Skeleton Letters. Composition and Spacing: Title Page; Lettering Plans and Working Drawings. Inscription Lettering. Letters for Stone; Shadows; Cast Letters; Raised Letters; Examples of Lettering; Gothic; Roman. Examination Plates.

ARCHITECTURE

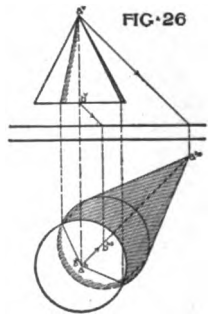
HISTORY OF ARCHITECTURE: Ancient Architecture; Egyptian; Assyrian; Grecian: Doric, Ionic and Corinthian Orders. Greek Tombs and Theatres; The Acropolis; Roman Architecture: Temples; Theatres; Tombs; Triumphal Arches; Medieval Architecture: Romanesque; Gothic; English Gothic; Early French Styles; Renaissance; Italian; French; Spanish; German; English. Classics. European Architecture. American Architecture: Colonial; Residences; Public Buildings; Churches; Commercial Architecture.

STUDY OF THE ORDERS: The Five Orders: Tuscan; Doric; Ionic; Corinthian; Composite: Character; Proportions; Uses; Typical Examples; Parallel of the Orders; Columns; Pilasters; Base; Shaft; Capital; Architrave; Frieze; Cornice; Arris; Entecis; Triglyphs; Metopes; Volutes; Modules. Proportion of Arches; Doorways; Pediments; Windows; Balustrades; Colonnades and Arches.

WORKING DRAWINGS: Details of Window Frames for Brick and Wooden Buildings; Details of rFaming: Floors; Partitions; Joists and Girders; Sills and Posts; Rafters; Attic Floor; Roof. Dormer Construction. Tenon and Tusk Joint. Hanger. Details: Bulkhead; Fireplace. Details of Finish; Sliding Doors; Ironwork in Connection with Framing. Details of Gutters.

ARCHITECTURAL DESIGN: Utility; Effect; Unity; Grouping; Interiors; Exteriors; Orders; Moldings; Greek and Roman Moldings; Pedestals; Arcades; Columns; Pilasters; Imposts; Balusters; Doors and Windows; Piers; Capitals; Spires; Form and Color. Ornament: Greek; Egyptian; Roman; Byzantine; Gothic; Italian; French; English. Plans: Rooms; Stairways. Entrance. City and Country Houses; Office Buildings: Light; Heating; Ventilation. Churches and Public Buildings.

BUILDING MATERIALS AND SUPERINTENDENCE: Limes; Cements and Mortars: Strength; Proportions; Data for Estimating Cost. Stone: Granite; Limestone; Marble; Slate; Testing Building Stone. Brick: Paving Brick; Fire Brick; Glazed and Enameled Brick; Building Brick. Size; Mortar; Construction of Walls; Hollow Walls; Brick Arches; Brick Veneer; Fireplaces. Terra Cotta: Composition and Manufacture. Durability; Inspection. Setting and Pointing. Examples of Construction. Iron and Steel: Girders and Lintels; Supports; Bearing Plates; Chimney Caps, etc. Laths and Plastering. Metal Laths; Stucco. Concrete. Superintendence: Necessity for Superintendence. Vists; Setting out the Building; Inspecting Material; Inspecting Construction; Costs; Contracts.



STRENGTH OF MATERIALS: Stresses and Deformations; Tension; Compression; Shear; Factors of Safety; Working Stresses. Beams: Simple Beams; Cantilever Beams; Reactions; Bending Moments; Moment of Inertia; Center of Gravity; Safe Loads; I-Beams; Deflection; Beams of Uniform Strength; Continuous Beams. Columns: Cross-sections; Radius of Gyration; Designing. Torsion: Shafts for Transmitting Power; Combined Stresses. Testing Timber, Brick, Cement, Wrought Iron, Cast Iron and Steel. Resilience: Sudden Loads and Impact: Elastic Resilience of Beams. Tension, Compression, Shear and Torsion.

FOUNDATIONS: Staking Out. Excavation; Loads; Artificial Foundations; Timber; Piles; Bearing Power; Cofferdam; Wrought Iron; Cast Iron; Blast Furnace Slag; Retaining walls; Concrete; Mixing; Laying; Compressive Strength; Period of Repose; Variations of Proportions. Shoring; Needling; Bracing.

MASONRY: Classes of Masonry; Culverts; Wing Walls; Pointing; Grouting; Freezing; Brick Masonry. Cement: Hydraulic; Natural; Portland; Characteristics of Portland Cement; Testing; Effect of Age; Quick and Slow Set; Specifications; Mortar; Proportions; Sand; Water; Strength of Mortar; Shearing, Compressive and Tensile Strength; Effect of Frost; Permanency; Data; Specifications.

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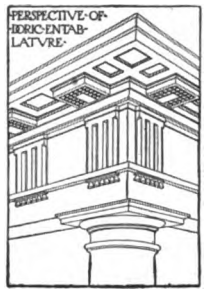
CARPENTRY AND JOINERY: Timber; Shake; Knots; Quarter Sawing; Seasoning; Kinds of Wood; Uses. Framed Structures: Joints; Sills; Posts; Studs; Bridging; Flooring; Partitions; Lathing; Trussed Partitions. Roofs: Jack Rafters; Hip and Valley; Mansard; Gables; Construction of Roofs: Shingles; Flashing. Balloon Framing. Siding; Verandas; Arches; Ceiling. Joinery: Joints; Tongue and Groove; Dovetail; Dowel; Mortise and Tenon; Keys. Interior Work: Wainscots; Paneling; Door Making; Sliding and Folding Doors; Windows: Sashes; Glass. Splayed Work. Bending Wood: Veneering. Blinds; Hinges; Interior Finish.

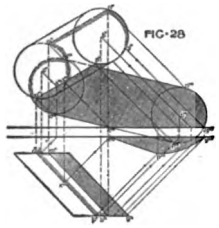
STAIR BUILDING: Materials; Terms; Classification. Construction: Treads; Risers; Stringers; Steps and Platform; Molding; Balustrades: Hand Rails. Straight Stairways; Winding Treads; Winders. Open and Closed Stringers; Curved Stringers. Quarter-Turn Winding; Half-Turn Platform. Winding Stairways; Circular Stairways.



GRAPHIC STATICS: Force Triangle; Polygon; Conditions of Equilibrium; Stresses in Truss, in Polygonal Frame; Reactions of Beams; Concentrated Loads; Uniform Loads; Overhanging Beams. Roof Trusses: Dead and Snow Loads; Stresses; Wind Loads; Fixed Ends; Truss with One End Free. Abbreviated Methods for Wind Stress; Complete Stresses for a Triangular Truss; Ambiguous Cases. Unsymmetrical Loads and Trusses. Stresses; Design Plate Girders.

STEEL CONSTRUCTION: Elements and Functions of Framework; Use of Handbooks; Rolled Shapes; Tables. Beams: Loads; Effect of Openings; Commercial and Practical Considerations in Design. Columns: Connections; Shapes; Selection; Calculation of Section; Tables; Use of Concrete Steel Columns. Trusses: Types; Determination of Loads; Shipping and Erection. Details of Framing: Connections of Beams to Girders and Columns; Plate and Box Girder Connections; Column Caps and Bases; Roof Details. Shop Drawings: Processes of Manufacture; Conventions; Mill and Shop Invoices; Checking; Details of Work. High Building Construction: Steel Skeleton; Limiting Heights; Laws; Effect of Wind. Portal, Knee and Diagonal Bracing. Vibration; Column Loads. Mill Construction: Requirements of Underwriters; Slow Burning Construction; Steel; Details of Connections. Types of Construction.

FIRE PROOFING: Material; Parts to be Protected; Choice of Material; Use of Material; Floor and Roof Arches; Comparison of Terra Cotta and Concrete Steel; Expanded Metal; Tests; Suspended Ceilings; Furring; Partitions; Column Coverings; Fire-Resisting Wood; Paint; Metal Coverings; Relation of Construction to Architect's Design. Relation of Construction to Strength of Steel Frame.



CONTRACTS AND SPECIFICATIONS: Classes; Drawing Up; Leak; Clauses: Subletting: Assignment. Failure to Complete Work; Insolvency; Insurance; Appliances; Disputes; Condemned Material. Penalties; Cost; Monthly Estimate; Final Acceptance; Definition of "Engineer" and "Contractor." Specifications: Forms; Clauses; Material; Workmanship; Performance; Specifications for Stone Work; Building; Lumber; Cement; Mortar; etc.

HEATING AND VENTILATION

HEATERS: Stoves; Furnaces; Steam; Hot Water; Electricity. Furnaces: Location; Parts; Direct and Indirect Draft; Pipes and Ducts. Care and Management. Ventilation: Carbonic Acid; Location of Inlets and Outlets; General Considerations. Heat Loss from Buildings. B. T. U. Calculations and Tables.

STEAM HEATING: Radiators; Systems of Piping; Wet and Dry Returns; Valves; Pipe Sizes; Indirect Steam Heating: Heaters; Stacks; Ducts; Wall Box; Care of Systems. Exhaust Steam Heating: Reducing Valves; Grease Extractor; Exhaust Head; Pumps and Traps; Paul System; Plenum Method; Efficiency of Heaters; Fans; Factory Heating; Temperature Regulators.

HOT WATER HEATING: Radiating Surface; Piping; Expansion Tank; Distribution; Valves and Pipes; Location of Radiators. Indirect Hot Water Heating: Heaters; Pipe Connections and Sizes; Care of Hot Water Heaters.

VENTILATION OF BUILDINGS: Choice of Systems; Calculations, and Hints for Heating and Ventilating School Houses, Theatres, Apartment Houses, Greenhouses, Factories, etc.

PLUMBING

FIXTURES: Bath Tubs; Water Closets; Lavatories; Bowls; Sinks; Traps; Pipes; Vents; Connections; Sewers and Cesspools. Plumbing: Connections for Bath Room. Kitchen Sink Connections. Plumbing Dwelling Houses, Apartment Houses, Railroad Stations, School Houses, and Factories. Testing and Inspection.

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DOMESTIC WATER SUPPLY: Friction in Pipes; Pipe Lining; Pumps; Hydraulic Ram; Kitchen Boiler; Coils; Water-Back Connections; Circulation Pipes; Laundry Boilers; Boilers with Steam Coils; Temperature Regulators.

SEWAGE: Systems; Considerations Governing Choice. Design and Construction: Topography; Manholes; Grades; Flushing; House Connections; Ventilation; Catch Basins; Pumping Stations. Purification; Sedimentation; Chemical Precipitation; Irrigation; Intermittent Filtration.

GAS FITTING: Pipes; Meters; Fittings; Joints; Risers; Location of Pipes; Testing Gas Pipes. Gas Fixtures: Burners: Batswing; Fishtail; Bunsen; Argand; etc. Chandeliers. Globes and Shades. Heating and Cooking by Gas. Automatic Hot-Water Heaters. Gas Meters: Position; Dials; Reading. Gas Machines.

MATHEMATICS

ALGEBRA, GEOMETRY, TRIGONOMETRY AND LOGARITHMS SEE SYNOPSIS PAGE 169

ARCHITECTURAL ENGINEERING

Prepared for Architects, Engineers, Contractors and Draftsmen who wish an intelligent knowledge of Structural Iron Work and Fireproofing as applied to Modern Office Buildings.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Geometry.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Freehand Drawing.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Algebra Part I.
Algebra Part II.
Perspective Drawing.
Mechanics Part I.
Mechanics Part II.
Trigonometry and Logarithms.
Strength of Materials Part I.
Strength of Materials Part II.
Foundations.
Masonry Construction Part I.
Masonry Construction Part II.
Statics.
Steel Construction Part I.
Steel Construction Part II.
Steel Construction Part III.
Steel Construction Part IV.
Fireproofing.

Tuition $55.00. Payable Monthly

SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers; Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition; Subtraction; Multiplication and Division of Decimals; Symbols of Aggregation.

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

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DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight: Avoirdupois; Troy; Apothecaries'; Surveyers' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation: Simple Equations; Transpositions; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions; Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse Complementary; Supplementary; etc. Parallel Lines; Axioms.

FUNDAMENTAL THEOREMS: Plane Figures; Polygons: Equilateral and Equiangular. Quadrilaterals; Circles; Measurements of Angles; Similar Figures; Trapezium; Trapezoid; Parallelogram; Rectangle; Square; Rhomboid; Rhombus. Ratio and Proportion. Terms; Alternation; Inversion; Composition and Division. The Circle: Theorems; Area; Circumferance, etc.

SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons: Rectangles, Parallelograms, etc.

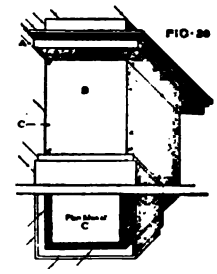
PROBLEMS OF CONSTRUCTION: Twenty-nine problems in Construction of Plane Figures.

MECHANICAL DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises in Line Work.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids; Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments; Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric; Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Co-ordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.



LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Centre; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads. Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts. Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for Solutions for Blue-Print Paper. Plates.

MECHANICS

PROPERTIES OF MATTER: Atoms and Molecules; Solids; Liquids; Gases; Extensibility; Impenetrability; Indestructibility; Inertia; Divisibility; Porosity; Hardness; Tenacity; Brittleness; Malleability; Ductility.

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MOTION, VELOCITY AND FORCE: Momentum: Newton's Laws; Parallelogram of Forces; Force Diagrams. Center of Gravity; Falling Bodies; Projectiles; The Pendulum; Kinetic and Potential Energy; Centrifugal Force.

PRINCIPLES OF MACHINES: Levers; Pulleys; Inclined Planes; Wedges; Screws; Laws of Friction; Coefficients of Friction. Tooth Gears: Spur; Worm; Bevel; Helical; Belt, Wire and Rope Gearing. Velocity Ratio; Horse Power Transmitted; etc.

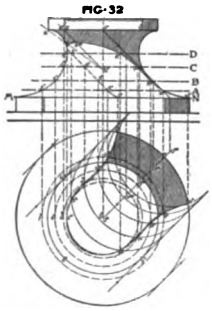
STRENGTH OF MATERIAS: Cohesion; Adhesion; Capillarity; Stress; Deformation; Elastic Limit; Breaking Strength; Coefficient of Elasticity; Tension; Compression; Shear; Torsion; Factor of Safety; Working Stress. Strength of Pipes and Cylinders; Strength of Beams and Columns; Moment of Inertia; Diagrams and Formulas.

HYDROSTATICS: Density; Specific Gravity; Hydrometers; Pressure of Fluids; Hydraulic Press; Head; Pressure Dams and Gates; Coefficients of Flow; Water Motors; Turbines.

PNEUMATICS: Barometers; Mariotte's Law; Suction Pumps.

ARCHITECTURE

BUILDING MATERIALS AND SUPERINTENDENCE: Limes; Cements and Mortars; Strength; Proportions; Data for Estimating Cost. Stone: Granite; Limestone; Marble; Slate; Testing Building Stone. Brick: Paving Brick; Fire Brick; Glazed and Enameled Brick; Building Brick. Size: Mortar; Construction of Walls; Hollow Walls; Brick Arches; Brick Veneer; Fireplaces. Terra Cotta: Composition and Manufacture. Durability; Inspection. Setting and Pointing. Examples of Construction. Iron and Steel: Girders and Lintels; Supports; Bearing Plates; Chimney Caps, etc. Laths and Plastering. Metal Laths; Stucco. Concrete. Superintendence: Necessity for Superintendence. Visits, Setting out the Building; Inspecting Material; Inspecting Construction; Costs; Contracts; Clauses.



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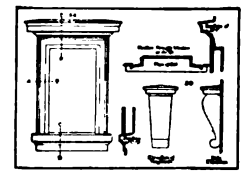

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FIRE PROOFING: Material; Parts to be Protected; Choice of Material; Use of Material; Floor and Roof Arches; Comparison of Terra Cotta and Concrete Steel; Expanded Metal; Tests; Suspended Ceilings; Furring; Partitions; Column Coverings; Fire-Resisting Wood; Paint; Metal Coverings; Relation of Construction to Architect's Design. Relation of Construction to Strength of Steel Frame.

CONTRACTORS' AND BUILDERS' COURSE

This course is designed to give a practical knowledge of the Construction of Large Buildings, together with Mechanical Drawing.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Geometry.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Architectural Drawing Part I.
Architectural Drawing Part II.
Building Superintendence Part I.
Building Superintendence Part II.
Strength of Materials Part I.
Strength of Materials Part II.
Masonry Part I.
Masonry Part II.
Carpentry and Joinery Part I.
Carpentry and Joinery Part II.
Sheet Metal Work Part I.
Sheet Metal Work Part II.
Metal Roofing.
Cornice Work.
Electric Wiring.
Electric Lighting.
Heating and Ventilation Part I.
Heating and Ventilation Part II.
Heating and Ventilation Part III.
Plumbing Part I.
Plumbing Part II.
Contracts and Specifications.
Legal Relations.

Tuition $55.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction, Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

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INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

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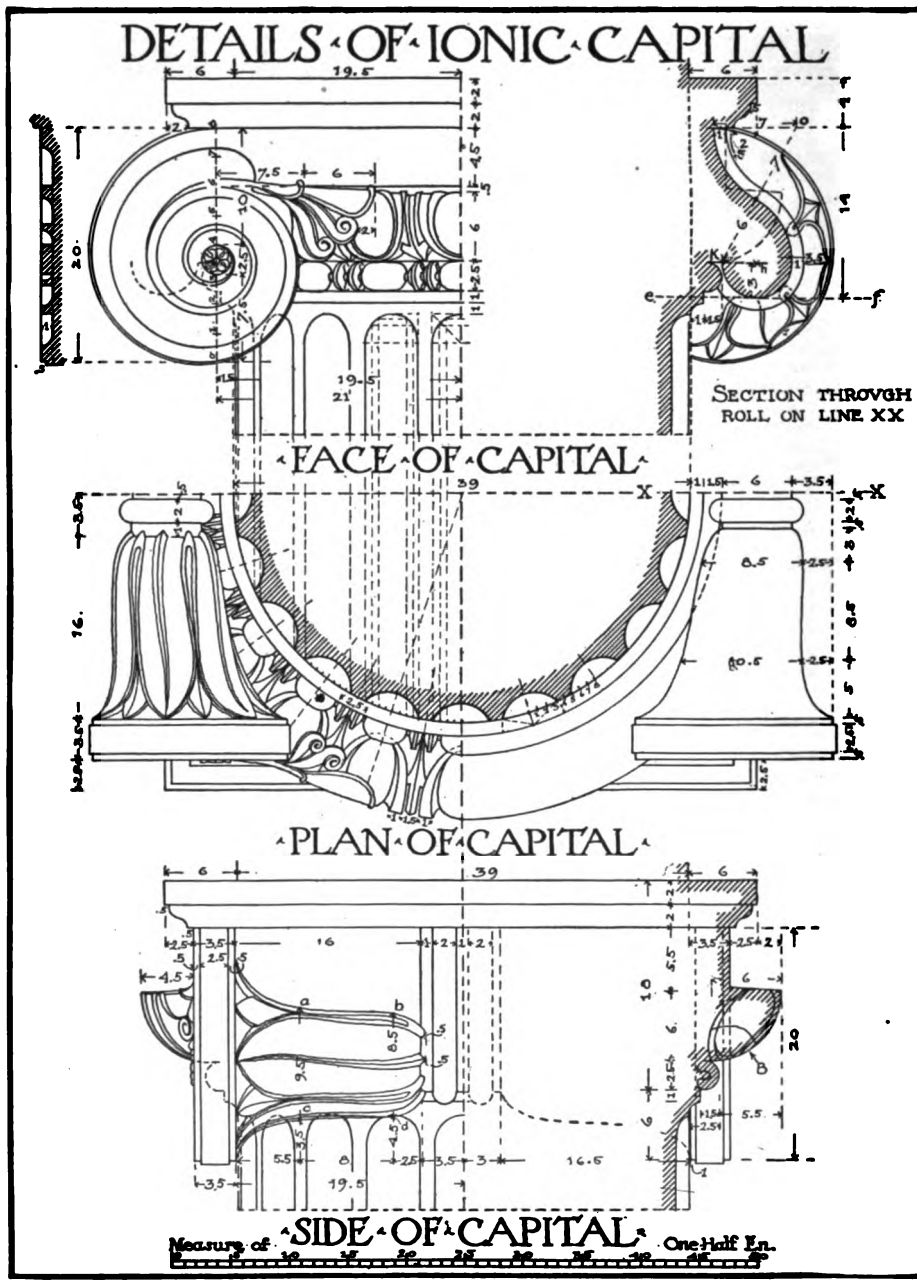

IONIC CAPITAL.

Specimen Plate from "Study of the Orders."
Original Plate 10x14 inches in size.

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GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse; Complementary; Supplementary; etc. Parallel Lines; Axioms.

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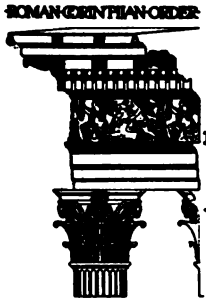

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WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Cross-hatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads. Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing: Formulas for Solutions for Blue-Print Paper. Plates.

ARCHITECTURE

WORKING DRAWINGS: Details of Window Frames for Brick and Wooden Buildings; Details of Framing: Floors; Partitions; Joists and Girders; Sills and Posts; Rafters; Attic Floor; Roof. Dormer Construction. Tenon and Tusk Joint. Hanger. Details. Bulkhead; Fireplace. Detail of Finish; Sliding Doors; Ironwork in Connection with Framing. Details of Gutters.

BUILDING MATERIALS AND SUPERINTENDENCE: Limes; Cements and Mortars: Strength; Proportions; Data for Estimating Cost. Stone: Granite; Limestone; Marble; Slate; Testing Building Stone. Brick: Paving Brick; Fire Brick; Glazed and Enameled Brick; Building Brick; Size; Mortar; Construction of Walls; Hollow Walls; Brick Arches; Brick Veneer; Fireplaces. Terra Cotta: Composition and Manufacture; Durability; Inspection; Setting and Pointing; Examples of Construction. Iron and Steel: Girders and Lintels; Supports; Bearing Plates; Chimney Caps, etc. Laths and Plastering. Metal Laths; Stucco. Concrete. Superintendence: Necessity for Superintendence. Visits; Setting out the Building; Inspecting Material; Inspecting Construction; Costs; Contracts; Clauses.

STRENGTH OF MATERIALS: Stresses and Deformations; Tension; Compression; Shear; Factors of Safety; Working Stresses. Beams: Simple Beams; Cantilever Beams; Reactions; Bending Moments; Moment of Inertia; Center of Gravity; Safe Loads; I-Beams; Deflection; Beams of Uniform Strength; Continuous Beams. Columns: Cross-sections; Radius of Gyration; Designing. Torsion: Shafts for Transmitting Power; Combined Stresses. Testing Timber, Brick, Cement, Wrought Iron, Cast Iron and Steel. Resilience: Sudden Loads and Impact: Elastic Resilience of Beams. Tension, Compression, Shear and Torsion.

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MASONRY: Classes of Masonry; Culverts; Wing Walls; Pointing; Grouting; Freezing; Brick Masonry. Cement: Hydraulic; Natural; Portland; Characteristics of Portland Cement; Testing; Effect of Age; Quick and Slow Set; Specifications; Mortar; Proportions; Sand; Water; Strength of Mortar; Shearing, Compressive and Tensile Strength; Effect of Frost; Permanency; Data; Specifications.

CARPENTRY AND JOINERY: Timber; Shake; Knots; Quarter Sawing; Seasoning: Kinds of Wood; Uses. Framed Structures: Joints; Sills; Posts; Studs; Bridging; Flooring; Partitions; Lathing; Trussed Partitions. Roofs: Jack Rafters; Hip and Valley; Mansard; Gables; Construction of Roofs: Shingles; Flashing. Balloon Framing. Siding; Verandas; Arches; Ceiling. Joinery: Joints; Tongue and Groove; Dovetail; Dowel; Mortise and Tenon; Keys. Interior Work: Wainscots; Paneling; Door Making; Sliding and Folding Doors; Windows: Sashes; Glass. Splayed Work. Bending Wood. Veneering. Blinds; Hinges; Interior Finish.

SHEET METAL WORK

SHEET METAL WORK: Tables; Tools; Methods of Obtaining Patterns; Intersections and Developments. Approximate Developments. Circular Molds. Practical Shop Problems: Bathtub, Hip Bath, Funnel Strainer, Pail, Sink Drainer, Ventilator, Elbows in Round, Square and Oval Pipes, Tapering Elbows in Round and Square Pipes, Tapering Elbow Round to Oval, Rain-water Cut-off, Transition Piece in Rectangular Pipe, Curved Rectangular Chute, Hopper Register Box, Transition Piece from Round Base to Round Top placed Vertically. Offset Round to Oval, Threeway Branch Round to Round, Two-branch Fork Oval to Round, Tapering Flange Around Pipe Passing Through an Inclined Roof. Round Pipe Intersecting Conical Furnace Top; to One Side of Center of Top, Sphere, Ogee Basin, Brewer's Kettle, Moulded Cap on Stack, Elbows in Heavy Metal, Intersecting Pipes in Boiler Work, Gusset Sheet on Boiler, Scroll Signs in Heavy Metal.

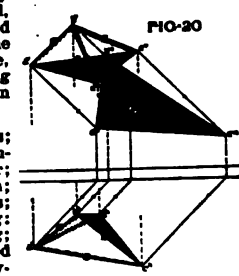
FIG-20

METAL ROOFING: Skylight Work: Tables; Tools; Patterns; Shapes of Bars and Curbs; Pitch; Hipped; Turrets; Conservatory; Photographic; Extension; Louvred. Ventilator; Curb; Hip Bar; Length of Bars. Coverings: Mensuration; Preparing Sheets; Laying; Base Flashings; Cap Flashings; Solder; Roof Flashing for Soil Pipes; Standing Seam Roofing: Locking Sheets; Preparing Roof; Bending; Cleats; Seaming; Finishing; Eaves and Ridge; Counter Flashing; Corrugated Roofing and Siding: Tables; Fastening Wood to Iron; Laying a Valley; Flashing Around Chimneys and Smokestack. End Wall Flashings. Ridge Rolls; Slidings and Awnings; Shapes of Flat Casings.

ELECTRICITY

ELECTRIC WIRING: Wire: Coverings; Standard Sizes; Insulating. Wire for High Voltage; Wire for Light and Power; Grades of Copper; Making Joints; Wiring Light Fixtures. Cleats, Casings and Tunnels; Wiring in Walls and Partitions. Standard Batteries; Care of Cells; Grouping for Bells, Telephone and Gas Lighting. Push Buttons; Annunciators; Bells; Gongs and Buzzers; Switches; Fuses; Meters; Burglar Alarms; Gas Lighters; Furnace Regulators. Wiring Plans: Sizes and Location of Wires; Returns; Fire Risks; Protection from Water; Insurance Rules and Regulations. Inspectors.

ELECTRIC LIGHTING: Definitions: Measurement of Candle Power; Bunsen Photometer; Incandescent Lamps; Efficiency; Life; Heating; Series Incandescent Lamps. Arc Lights: Principles; Carbons; Operation; Detail Parts.

SYSTEMS OF DISTRIBUTION: Series: Multiple Series; Parallel and Loop Systems; Feeders; Pilot Wires; Three and Five Wire Systems; Alternating Current System. Location of Lamps; Horse Power Required for Lighting. Plant: Location and Equipment. Conductors: Circular Mill Overhead and Underground Systems. Details. Wiring Buildings: Calculations; Allowable Drop of Potential.

HEATING AND VENTILATION

HEATING AND VENTILATION: Stoves; Furnaces; Boilers; Electricity. Ventilation; Carbonic Acid; Location of Inlets and Outlets; General Considerations. Heat Loss from Buildings: B. T. U. Causes of Loss; Calculations and Tables.

FURNACE HEATING: Furnaces; Location; Parts; Direct and Indirect Draft; Cold-Air Box; Pipes, Ducts and Registers. Care and Management.

STEAM HEATING: Radiators; Systems of Piping; Wet and Dry Return; Connections; Valves; Pipe Sizes. Indirect Steam Heating: Heaters; Stacks and Casings; Dampers; Flues and Ducts; Care of Systems.

HOT-WATER HEATING: Heaters; Piping; Expansion Tank; Overhead Distribution; Valves and Fittings; Pipe Sizes; Location of Radiators. Indirect Hot-Water Heating; Sizes of Heaters; Pipe Connections and Sizes.

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EXHAUST-STEAM HEATING: Reducing Valves; Grease Extractor; Exhaust Head; Pumps and Traps; Paul System; Plenum Method; Efficiency of Heaters; Fans and Blowers; Factory Heating; Double-Duct Systems. Temperature Regulators.

VENTILATION OF BUILDINGS: Choice of Systems, Calculations and Hints for Heating and Ventilating School Houses, Theatres, Apartment Houses, Greenhouses, Factories, etc.

STEAM FITTING: Supply of Pipe; Cutting Pipe; Tools; Making and Packing Joints; Flange Unions.

PLUMBING

FIXTURES: Bath Tubs; Water Closets; Urinals; Lavatories; Bowls; Sinks; Traps; Faucets; Soil and Waste Pipes; Connections. Traps and Vents; Fresh-Air Inlets; Sewers and Cesspools.

PLUMBING FOR VARIOUS BUILDINGS: Bath Room: Location and Connections; Kitchen Sink Connections; Plumbing Dwelling Houses; Apartment Houses; Railroad Stations; School Houses; Shops and Factories. Testing and Inspection: Ether, Peppermint, and Smoke Tests.

DOMESTIC WATER SUPPLY: Friction in Pipes; Pipe Lining; Pumps; Hydraulic Ram; Kitchen Boiler; Coils; Water-Back Connections; Circulation Pipes; Laundry Boilers; Boilers with Steam Coils; Temperature Regulators.

SEWAGE: Systems; Considerations Governing Choice. Design and Construction of Sewers: Topography; Manholes; Grades; Flushing; House Connections; Ventilation; Catch Basins; Pumping Stations. Purification: Sedimentation; Chemical Precipitation; Irrigation; Intermittent Filtration.

GAS FITTING: Pipes; Meters; Fitting; Joints; Risers; Location of Pipes; Pipe Sizes; Testing Gas Pipes. Gas Fixtures; Burners: Batswing; Fishtail; Bunsen; Argand; etc. Chandeliers, Globes and Shades. Heating and Cooking by Gas. Automatic Hot-Water Heaters. Gas Meters: Position; Dials; Reading. Gas Machines.

CONTRACTS AND SPECIFICATIONS

CONTRACTS: Classes; Drawing Up; Seals; Clauses: Subletting: Assignment. Failure to Complete Work; Insolvency; Insurance; Appliances; Disputes; Condemned Material. Penalties; Cost; Monthly Estimate; Final Acceptance; Definition of "Engineer" and "Contractor." Specifications: Forms; Clauses: Material; Workmanship; Performance. Specifications for Stone Work; Building; Lumber; Cement; Mortar; etc.

ARCHITECTURAL DRAWING

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Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Architectural Lettering.
Shades and Shadows.
Architectural Drawing Part I.
Architectural Drawing Part II.
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Rendering.
Study of the Orders Part I.
Study of the Orders Part II.
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SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

FRACTIONS: Definitions; Proper and Improper Fractions; Reductions of Fractions; Least Common Multiple; Least Common Denominator; Addition; Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation. Percentage: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure: Measures of Weight; Avoirdupois; Troy; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Boiler.

GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse Complementary; Supplementary; etc. Parallel Lines; Axioms.

FUNDAMENTAL THEOREMS: Plane Figures; Polygons: Equilateral and Equiangular. Quadrilaterals; Circles; Measurements of Angles; Similar Figures; Trapezium; Trapezoid; Parallelogram; Rectangle; Square; Rhomboid; Rhombus. Ratio and Proportion. Terms: Alternation; Inversion; Composition and Division. The Circle.

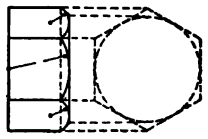
SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons; Rectangles, Parallelograms, etc. Twenty-nine problems in Construction.

DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse: Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection: True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric; Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections; Difference between Oblique Projection and Isometric. Shade Lines.



WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads. Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing.

PERSPECTIVE DRAWING: Station Point; Picture Plane; Ground Line; Horizon; Line of Measures; Axis; Vertical Trace; Horizontal Trace; Bird's-eye View; Worm's-eye View; Vanishing Points. Projections: Planes; Notation. Problems Involving Perspective of Points, Lines and Planes. Revolved Plan; Lines of Measure; Diagrams; Revolved Plan and Elevation; Systems of Lines and Planes; Visual Ray; Method of Perspective Plan; Curves; Apparent Distortion; Choice of Position of Station Point.

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SHADES AND SHADOWS: Principles and Notation; Shadows of Points, Lines and Planes. Co-ordinate Planes; Lines on More Than One Surface. Choosing Ground Line. Problems: Shadows of Prism; Pedestal; Chimney on Roof; Rail on Steps; Cone; Cylinder. Auxiliary Planes; Shadow of Spherical Hollow; Shadow of Scotia. Planes of Light; Shadow of a Sphere; Shadow on Pediment Moulding. Short Methods: Shadows of Points; Lines Parallel and Perpendicular to Co-ordinates Planes. Shadows on Inclined Planes; on Planes Parallel and Perpendicular to Co-ordinate Planes. Shade and Shadow of Cylinder; of Line Moulding; on Intrados of Circular Arch; of Spherical Hollow and Niche; of Sphere; of Torus.

RENDERING: Kinds of Drawing. Materials Used in Rendering: Pens; Ink; Paper. Examples Showing Common Faults. Values; Lighting; Color of Material; Rendering by Shadows Only. Accent. Pencil Work. Suggestions and Cautions. Drawings.

FREE HAND DRAWING: Paper; Pencils; Drawing Board. Difference between a Drawing and a Photograph. Lines and Surfaces. Flat Ornament: Anthemia; Frets; Mosaics; Stained Glass; All Over Patterns. Light and Shade: Value Scale; Form Drawing; Point of View; Value Drawing; Point of View of Painter. Geometric Solids. Carved Ornament: Rosettes; Greek, Roman and Byzantine Acanthus; Ionic; Corinthian and Gothic Capitals; Renaissance Pilaster.

ARCHITECTURAL LETTERING: Office Lettering; Purpose; Relative Sizes and Shapes of Letters for Titles; Forms and Proportions of Various Alphabets. Skeleton Letters. Composition and Spacing: Title Page; Lettering Plans and Working Drawings. Inscription Lettering. Letters for Stone; Shadows; Cast Letters; Raised Letters; Examples of Lettering; Gothic; Roman. Examination Plates.

STUDY OF THE ORDERS: The Five Orders: Tuscan; Doric; Ionic; Corinthian; Composite. Character; Proportions; Uses; Typical Examples; Parallel of the Orders; Columns; Pilasters; Base; Shaft; Capital; Architrave; Frieze; Cornice; Arris; Entecis; Triglyphs; Metopes; Volutes; Modules. Arches; Doorways; Pediments; Windows; Balustrades; Colonnades and Arches.

ARCHITECTURAL DESIGN: Utility; Effect; Unity; Grouping; Interiors; Exteriors; Orders; Moldings; Greek and Roman Moldings; Pedestals; Arcades; Columns; Pilasters; Imposts; Balusters; Doors and Windows; Piers; Capitals; Spires; Form and Color. Ornament: Greek; Egyptian; Roman; Byzantine; Gothic; Italian; French; English. Plans: Rooms; Stairways. Entrance. City and Country Houses; Office Buildings: Light; Heating; Ventilation. Churches and Public Buildings.

CARPENTERS' COURSE

Prepared for Carpenters and Contractors engaged in Dwelling House Work. It aims to aid the student in reading drawings and making attractive sketches for clients. It teaches the principles of Planning, Strength of Materials, Framing, Estimating, etc.

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Geometry.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Freehand Drawing.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Architectural Drawing Part I.
Architectural Drawing Part II.
Perspective Drawing.
Masonry Construction Part I.
Masonry Construction Part II.
Strength of Materials Part I.
Strength of Materials Part II.
Carpentry and Joinery Part I.
Carpentry and Joinery Part II.
Stair Building.

Tuition $40.00. Payable Monthly.

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SYNOPSIS OF COURSE

ARITHMETIC

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

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PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

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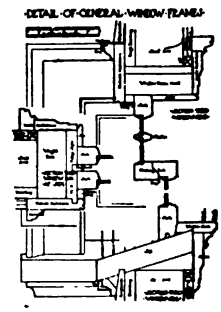
SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons: Rectangles, Parallelograms, etc. Twenty-nine problems in Construction.

MECHANICAL DRAWING

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises.



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LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Drawings.

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads, Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for Blue-Print Paper. Plates.

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PERSPECTIVE DRAWING

THEORY AND DEFINITIONS: Station Point; Picture Plane; Ground Line; Horizon; Line of Measures; Axis; Vertical Trace, Horizontal Trace; Bird's-eye View; Worm's-eye View; Vanishing Point of Horizontal Lines; Vanishing Point of Vertical Lines; Vanishing Point of Oblique Lines.

PERSPECTIVE AND PROJECTIONS: Axioms; Planes; Notation; Problems Involving Points, Lines, Planes and Vanishing Points. Revolved Plan: Lines of Measure; Vanishing Points; Diagrams; Revolved Plan and Elevation; Systems of Lines and Planes: Visual Rays; Perspective Diagram.

PARALLEL OR ONE-POINT PERSPECTIVE: Method of Perspective Plan; Curves; Apparent Distortion, Choice of Position of Station Point. Plates.

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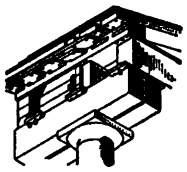

WORKING DRAWINGS: Details of Window Frames for Brick and Wooden Buildings; Details of Framing;: Floors; Partitions; Joists and Girders; Sills and Posts; Rafters; Attic Floor; Roof. Dormer Construction. Tenon and Tusk Joint. Hanger. Details: Bulkhead; Fireplace. Details of Finish; Sliding Doors; Ironwork in Connection with Framing. Details of Gutters.

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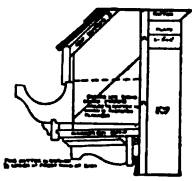

STAIR BUILDING: Materials; Terms; Classification. Construction: Treads; Risers; Stringers; Steps and Platform; Molding; Balustrades: Hand Rails. Straight Stairways; Winding Treads; Winders. Open and Closed Stringers; Curved Stringers. Quarter-Turn Winding; Half-Turn Platform. Winding Stairways: Various Forms. Circular Stairways.

CONTRACTS AND SPECIFICATIONS: Classes; Drawing Up; Leak; Clauses; Subletting: Assignment. Failure to Complete Work; Insolvency; Insurance; Appliances; Disputes; Condemned Material. Penalties; Cost; Monthly Estimate; Final Acceptance; Definition of "Engineer" and "Contractor." Specifications: Forms; Clauses; Material; Workmanship; Performance; Specifications for Stone Work; Building; Lumber; Cement; Mortar; etc.

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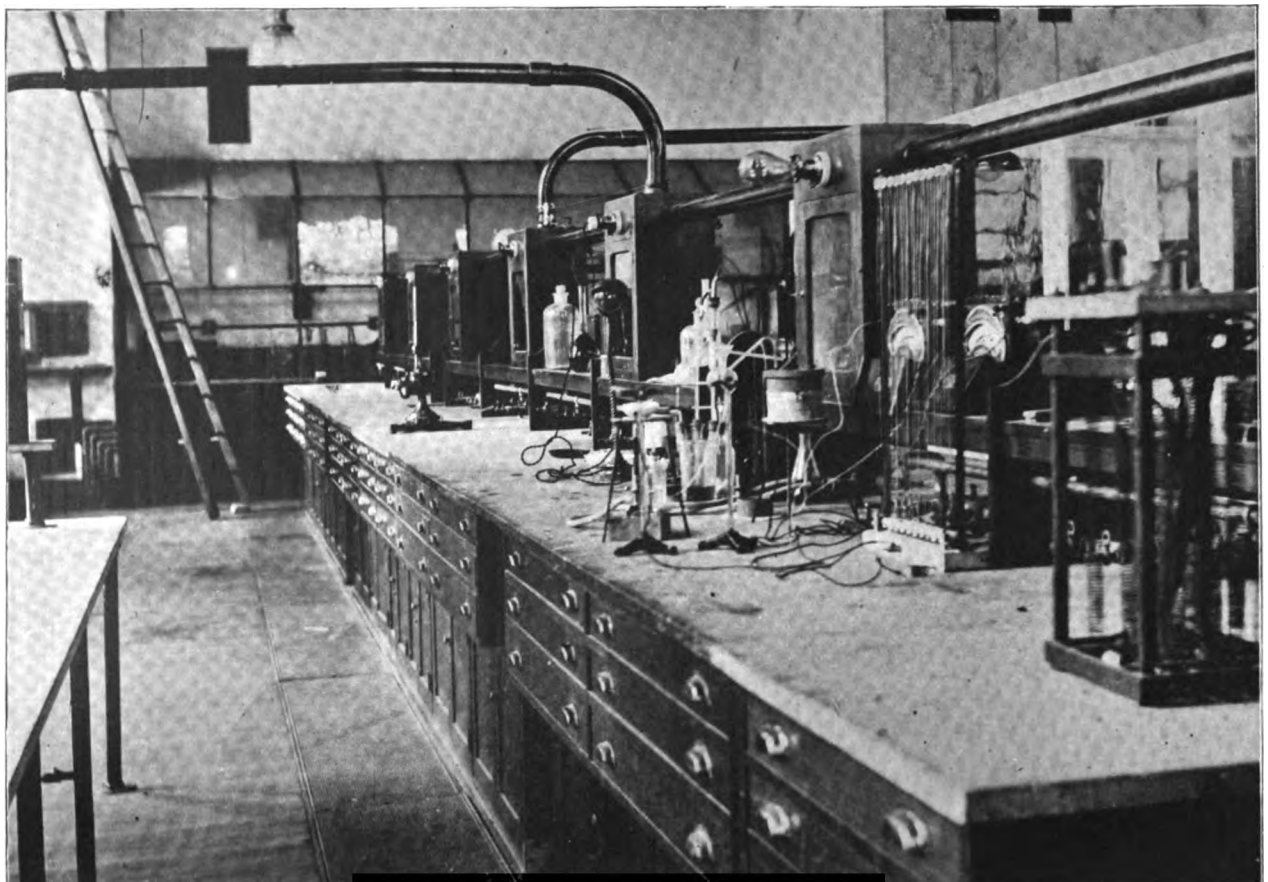

Electro-Chemical Laboratory, Columbia University

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TEXTILE MANUFACTURING.

Partial list of well-known authorities and educators who personally have prepared the Instruction Papers for correspondence study.

FENWICK UMPLEBY,
Head of Dept. of Fabric Structure and Textile Design, Lowell Textile School.

LOUIS A. OLNEY, A. C.,
Head of Dept. of Textile Chemistry and Dyeing, Lowell Textile School.

H. WILLIAM NELSON,
Head of Dept. of Warp Preparation and Weaving, Lowell Textile School.

J. F. TIMMERMANN,
Formerly with Central Woolen Co., Wilton Woolen Co., etc.

C. C. HEDRICK,
Mechanical Engineer, Lowell Machine Shop.

M. A. METCALF,
Managing Director of the Textile American.

MILES COLLINS,
Superintendent of the Abbott Worsted Mills.

OTIS L. HUMPHREY,
Formerly Head of Dept. of Cotton Spinning, Lowell Textile School.

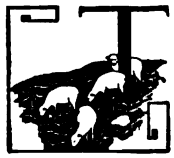
W. H. FAUNCE,
Formerly Superintendent, Camden Woolen Co.

W. M. HASTINGS,
Formerly with Bemis Mills and Nonantum Worsted Co.

COURSES

COMPLETE WOOLEN AND WORSTED MANUFACTURING
COMPLETE COTTON MANUFACTURING
COMPLETE KNIT GOODS MANUFACTURING
TEXTILE DESIGNING AND FABRIC STRUCTURE
TEXTILE CHEMISTRY AND DYEING
KNITTING
WARP PREPARATION AND WEAVING
WOOLEN AND WORSTED FINISHING
COTTON SPINNING
WOOLEN AND WORSTED SPINNING

TEXTILE MANUFACTURING.



THE tendency of the twentieth century is toward specialization. To fill a responsible position in any branch of industry, a man must be a specialist and devote every effort to the perfection of his knowledge. The textile industry is no exception to this rule and there is no branch that offers broader inducements to a young man.

The high degree of perfection which has been attained in textile machinery and the processes of manufacture have increased the de-

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mand for men of ability to direct the operations. Finer grades of fabrics are being manufactured; new mills are being erected; old mills are being enlarged and new machinery installed. We are reaching out to foreign countries for markets, and there is demand for men with a knowledge of textiles to represent selling houses in these markets. Never before were there so many opportunities for the man with a knowledge of textiles; never before was such an opportunity to fit yourself for a better position.

The Textile Courses of the American School of Correspondence have been prepared to enable young men to qualify for positions of trust and responsibility. Instruction papers have been prepared by successful manufacturers and noted educators in resident textile schools, which ensures a valuable combination of theoretical and practical knowledge.

We wish to call particular attention to the Instruction Papers on Knitting, and Textile Chemistry and Dyeing. Our Course in Knitting is the only one in the country, if not in the world, and is prepared in such a practical and common-sense manner that no one who studies it can fail to be benefited.

In Textile Chemistry and Dyeing, all the operations of an up-to-date dye house are explained; formulas and recipes are given in abundance, and, if carefully studied, it will enable anyone to become an expert dyer.

The Complete Courses are arranged to give thorough instruction in every department of manufacture. They are very complete, and present the subjects in a very clear manner. Each complete course contains a number of papers on subjects which, while not strictly Textile, are closely allied to the Textile Industry. These papers cover problems which arise in every mill and with which every superintendent ought to be familiar. However, they are optional and may be omitted if the student chooses.

A number of short, special courses have been arranged for men who cannot find time to complete a full course or for those who desire to specialize in one department of Textile Manufacture.

A careful study of the following synopses will explain the nature of the courses, and convince any one of the superiority of our instruction over that given by other correspondence institutions.

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†COMPLETE WOOLEN AND WORSTED MANUFACTURING.

Prepared for Mill Superintendents, Boss Woolen and Worsted Carders, Spinners, Finishers, Weavers, Dyers, Worsted Combers, Designers, Mill Agents and Treasurers, Selling Agents, and all persons desirous of fitting themselves for responsible positions in the Woolen Industry.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Woolen and Worsted Spinning Part I.
Woolen and Worsted Spinning Part II.
Woolen and Worsted Spinning Part III.
Woolen and Worsted Spinning Part IV.
Warp Preparation.
Weaving Part I.
Weaving Part II.
Weaving Part III.
Textile Calculations.
Textile Design Part I.
Textile Design Part II.
Textile Design Part III.
Textile Design Part IV.
Textile Design Part V.
Heat.
Elements of Chemistry.
Textile Chemistry and Dyeing Part I.
Textile Chemistry and Dyeing Part II.
Textile Chemistry and Dyeing Part III.
Textile Chemistry and Dyeing Part IV.
Woolen and Worsted Finishing Part I.
Woolen and Worsted Finishing Part II.
Woolen and Worsted Finishing Part III.
Heating and Ventilation Part I.
Heating and Ventilation Part II.
Heating and Ventilation Part III.

*Optional.

Tuition $50.00. Payable Monthly.

The Diploma is awarded on completion of the above Examination Papers. The Graduate may take either one of the following groups of options if the above papers are completed within two years:

STEAM

Construction of Boilers.
Types of Boiler.
Boiler Accessories.
Steam Pumps.
The Steam Engine Part I.
Indicators.
Valve Gears.
The Steam Engine Part II.

ELECTRICAL

Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Types of D. E. Machinery.
Electric Lighting.

†NOTE: For Synopsis, see Textile Bulletin, sent on request.

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†COMPLETE COTTON MANUFACTURING.

Prepared for Cotton Mill Superintendents, Boss Carders, Spinners, Combers, Weavers, Dyers, Designers, Mill Agents and Treasurers, Selling Agents and all persons desirous of fitting themselves for responsible positions in the Cotton Industry.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Cotton Fiber.
Cotton Spinning Part I.
Cotton Spinning Part II.
Cotton Spinning Part III.
Cotton Spinning Part IV.
Cotton Spinning Part V.
Warp Preparation.
Weaving Part I.
Weaving Part II.
Weaving Part III.
Textile Calculations.
Textile Design Part I.
Textile Design Part II.
Textile Design Part III.
Textile Design Part IV.
Textile Design Part V.
Heat.
Elements of Chemistry.
Textile Chemistry and Dyeing Part I.
Textile Chemistry and Dyeing Part II.
Textile Chemistry and Dyeing Part III.
Textile Chemistry and Dyeing Part IV.
Heating and Ventilation Part I.
Heating and Ventilation Part II.
Heating and Ventilation Part III.

The papers on Chemistry and Dyeing contain instruction on finishing cotton goods.

*Optional.

Tuition $50.00. Payable Monthly.

The Diploma is awarded on completion of the above Examination papers. The Graduate may take either one of the following groups of options, if the above Papers are completed within two years.

STEAM

Construction of Boilers.
Types of Boilers.
Boiler Accessories.
Steam Pumps.
The Steam Engine Part I.
Indicators.
Valve Gears.
The Steam Engine Part II.

ELECTRICAL

Elements of Electricity.
The Electric Current.
Theory of Dynamo-Electric Machinery.
Direct Current Dynamos.
Direct Current Motors.
Types of D.-E. Machinery.
Electric Lighting.

†NOTE: For Synopsis, see Textile Bulletin, sent on request.

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†COMPLETE KNIT GOODS MANUFACTURING.

Prepared for Superintendents, Boss Knitters and Finishers, Fixers, Mill Agents and Treasurers, Selling Agents and all persons desirous of perfecting their knowledge of the Knitting Industry. There is a wide field for men with an extensive knowledge of this subject.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Cotton Fiber.
Cotton Spinning Part I.
Cotton Spinning Part II.
Cotton Spinning Part III.
Cotton Spinning Part IV.
Cotton Spinning Part V.
Woolen and Worsted Spinning Part I.
Woolen and Worsted Spinning Part II.
Woolen and Worsted Spinning Part III.
Woolen and Worsted Spinning Part IV.
Knitting Part I.
Knitting Part II.
Knitting Part III.
Knitting Part IV.
Heat.
Elements of Chemistry.
Textile Chemistry and Dyeing Part I.
Textile Chemistry and Dyeing Part II.
Textile Chemistry and Dyeing Part III.
Textile Chemistry and Dyeing Part IV.
Heating and Ventilation Part I.
Heating and Ventilation Part II.
Heating and Ventilation Part III.

*Optional.

Tuition $50.00. Payable Monthly.

The Diploma is awarded on completion of the above Examination Papers. The Graduate may take either one of the following groups of options, if the above papers are completed within two years.

STEAM	ELECTRICAL
Construction of Boilers.	Elements of Electricity.
Types of Boilers.	The Electric Current.
Boiler Accessories.	Theory of Dynamo-Electric Machinery.
Steam Pumps.	Direct Current Dynamos.
The Steam Engine Part I.	Direct Current Motors.
Indicators.	Types of D.-E. Machinery.
Valve Gears.	Electric Lighting.
The Steam Engine Part II.	

†NOTE: For Synopsis, see Textile Bulletin, sent on request.

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†TEXTILE DESIGNING AND FABRIC STRUCTURE.

A concise, practical course prepared for Superintendents, Assistant Superintendents, Designers, Assistant Designers, Boss Weavers, Weavers, Selling Agents, Commission Men and others. The field for young designers is very broad, as there is a large and ever-increasing demand for fancy goods.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Warp Preparation.
Textile Calculations.
Textile Design Part I,
Textile Design Part II.
Textile Design Part III.
Textile Design Part IV.
Textile Design Part V.

*Optional.

Tuition $30.00. Payable Monthly.

†TEXTILE CHEMISTRY AND DYEING.

A concise, practical course prepared for Boss Dyers of Cotton, Wool and Silk, Second Hands, Bleachers, Salesmen and others. By studying this course it is possible for a young man to become an expert dyer without the assistance of friendly dyers.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Albegra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Heat.
Elements of Chemistry.
Textile Chemistry and Dyeing Part I.
Textile Chemistry and Dyeing Part II.
Textile Chemistry and Dyeing Part III.
Textile Chemistry and Dyeing Part IV.

*Optional.

Tuition $30.00. Payable Monthly.

NOTE: For Synopsis, see Textile Bulletin, sent on request.

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†KNITTING.

A concise, practical course prepared for Boss Knitters, and Fixers, on Latch and Spring Needle Work, Boss Finishers, Knit Goods Selling Agents and young men who are desirous of fitting themselves for responsible positions in the knit goods industry.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Textile Calculations.
Heat.
Knitting Part I.
Knitting Part II.
Knitting Part III.
Knitting Part IV.

*Optional.

Tuition $30.00. Payable Monthly.

†WOOLEN AND WORSTED SPINNING.

Prepared for Boss Woolen and Worsted Spinners, Worsted Combers, Second Hands, Section Hands, Yarn Selling Agents and young men who are desirous of qualifying for any of the foregoing positions.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Textile Calculations.
Heat.
Woolen and Worsted Spinning Part I.
Woolen and Worsted Spinning Part II.
Woolen and Worsted Spinning Part III.
Woolen and Worsted Spinning Part IV.

*Optional.

Tuition $30.00. Payable Monthly.

†NOTE: For Synopsis, see Textile Bulletin, sent on request.

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†WARP PREPARATION AND WEAVING.

Prepared for Boss Weavers, and Second Hands of Cotton, Woolen and Worsted Mills. Loom Fixers, Slasher Tenders, Boss Dressers, Dresser Tenders and others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Textile Calculations.
Heat.
Warp Preparation.
Weaving Part I.
Weaving Part II.
Weaving Part III.

*Optional.

Tuition $30.00. Payable Monthly.

†WOOLEN AND WORSTED FINISHING.

Prepared for Boss Finishers, Fullers, and others. Any one wishing to qualify for a responsible position in the finishing department of a woolen or worsted mill should study this course.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Textile Calculations.
Heat.
Woolen and Worsted Finishing Part I.
Woolen and Worsted Finishing Part II.
Woolen and Worsted Finishing Part III

*Optional.

Tuition $30.00. Payable Monthly.

†NOTE: For Synopsis, see Textile Bulletin, sent on request.

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†COTTON SPINNING.

A concise, practical course prepared for Boss Cotton Spinners, Combers, Second Hands, Section Hands, Yarn Selling Agents and young men who are desirous of qualifying for any of the foregoing positions.

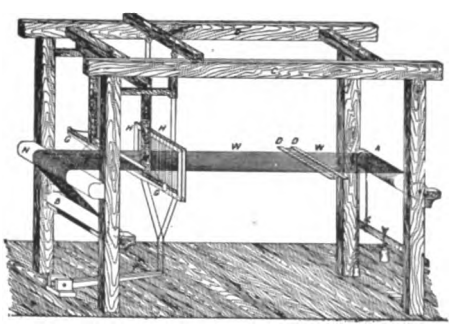
INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
*Elementary Algebra and Mensuration.
*Mechanics Part I.
*Mechanics Part II.
*Mechanism.
Textile Calculations.
Heat.
Cotton Fiber.
Cotton Spinning Part I.
Cotton Spinning Part II.
Cotton Spinning Part III.
Cotton Spinning Part IV.
Cotton Spinning Part V.

*Optional.

Tuition $30.00. Payable Monthly.

†NOTE: For Synopsis, see Textile Bulletin, sent on request.



Hand Loom.

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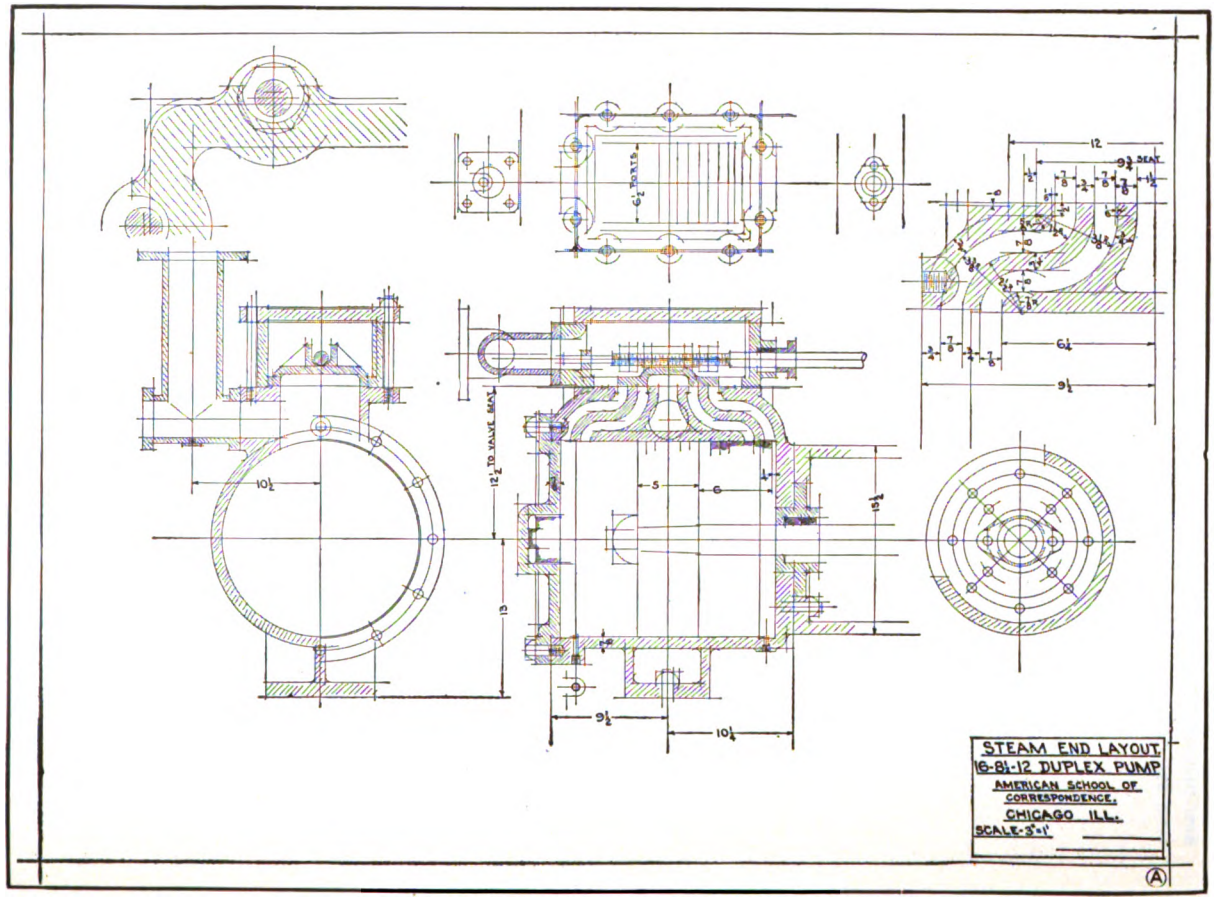

Mechanical Drawing Plate. (Pencil Layout.)

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DEPARTMENT OF DRAWING

COURSES

MECHANICAL DRAWING
PERSPECTIVE DRAWING

DRAWING

DRAWING is the language of the Engineer, Mechanic and Architect. It is the best method for recording ideas and calculations and for showing small details. A short inspection of an accurate, well-executed drawing will give a clearer idea of a machine and better instructions for making and finishing than any amount of oral or written explanation.

The Mechanical Drawing of this department is given in six instruction papers. It includes the use of instruments, geometrical drawing and projections—orthographic, isometric and oblique. The principles of projection are carefully explained and their relation to practical working drawings pointed out. Lettering—Gothic, Roman and Architectural—precedes the study of working drawings so that these drawings may have suitable titles and neatly executed notes and dimensions.

The making of working shop drawings and blue-prints is the most important part of the course. The location of views, the number and position of sections, conventional forms of screw threads, methods of representing broken pieces and best ways of placing dimensions receive careful attention. In addition to directions for making blue-prints, receipts are given for preparing the paper. The sixth paper takes up the duplex steam pump, showing the preliminary layout, pencil sketches, finished drawings, tracings and the assembly drawing. The work is made as practical as possible, stress being laid upon the importance of making the clearest, most instructive drawing at the least cost.

The Perspective Drawing forms a part of the preliminary work in Architecture. It includes the use of ground line, vanishing points, station points, line of measures, etc.

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MECHANICAL DRAWING

A short, practical course prepared for Mechanics, Apprentices, Engineers, Firemen, Students and others wishing to qualify themselves for positions as Draftsmen and Designers of Machinery.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Freehand Drawing.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanism.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.
Perspective Drawing.
*Algebra Part I.
*Algebra Part II.
*Trigonometry and Logarithms.
*Machine Design Part I.
*Machine Design Part II.

*Optional.

Tuition $50.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

ARITHMETIC PART II

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

ARITHMETIC PART III

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight; Avoirdupois; Troy; Apothecaries'; Surveyers' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

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MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

MECHANICAL DRAWING

PART I

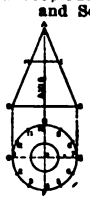
INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates: Exercises in Line Work.

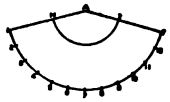
PART II

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

PART III

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.





LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

PART IV

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads. Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for Solutions for Blue-Print Paper. Plates.

PART V

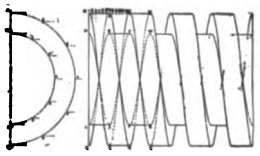
DETAILED DRAWINGS: The Helix; Pitch; Springs; Conventional Representations; V-Thread; Square Thread; Standard Threads. Cams: Kinds of Motion; Kinds of Cams; Designing.

GEARING: Belt: Parallel Shafts; Open and Crossed Belts; Quarter-Turn Belt; Reversible Quarter-Turn Belt with Two Guide Pulleys; With One Guide Pulley. Belts Connecting Non-Parallel Shafts whose Axes Intersect. Belt Holes. Tooth Gearing: Pitch Circles; Addendum; Back Lash; Diametrical Pitch; Cycloidal and Involute Gears; Epicycloidal Spur Gears. Annular Gears; Rack and Pinion; Involute Gears; Bevel Gears. Plates.

PART VI

WORKING SHOP DRAWINGS: Plan and Scope of Advanced Work; Essentials; Completeness of Drawings; Cost of Producing; Method of Procedure.

DUPLEX PUMP PLATES: Rating of Pump; Steam-End Layout; Molding and Machining of Steam End. Dimensions and Letters; System; Accuracy; Clearness; Completeness; Character; Inking and Tracing; Dimensions; Abbreviations; Piston Rod and Valve Stem; Molding and Machining; Steam Chest and Valve; Valve-Motion Layout and Details; Yoke; Stuffing Boxes; Brackets; Water-end Layout; Water Cylinder; Cap; Air Chamber; Plunger; Valve Details; Foundation; General Drawing.



ORDER SHEETS: List of Castings and Miscellaneous Parts: Bolts; Nuts; Pins; Special Fittings; Wrenches.

PLATES: Details; Assembly Drawing of Pump; Tracing.

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MACHINE DESIGN

DEFINITION AND RELATION: Theoretical and Commercial Considerations; Invention; Original Design; Handbooks; General Reference Books; Empirical Data; Calculations; Notes; Records.

CONSTRUCTIVE MECHANICS AND DESIGN: Forces; Moments; Beams. Tension; Compression; Torsion. Friction and Lubrication. Working Stresses; Strains. Analysis of Conditions and Forces; Theoretical Construction; Practical Modification; Delineation and Specification.

APPLICATION TO POWER TRANSMISSION: Speed Ratio; Power; Load; Efficiency; Preliminary Calculation; Layout; Design of Parts; Belts; Pulleys; Shafts; Gears. Couplings; Clutches; Brakes. Bearings; Brackets; Stands; Bolts; Nuts; Screws; Keys; Pins; Cotters.

SIMPLE MACHINE ELEMENTS: Types; Materials; Shop Machinery; Processes; Construction; Cost; Competition; Machinery Market. Working Detail Drawings of Parts in a Practical Case of Power Transmission.

PERSPECTIVE DRAWING

A thorough course prepared for Architects, Teachers, Students in Architecture, Ornamental Draftsmen, Artists and Others.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Freehand Drawing.
Mechanical Drawing Part III.
Perspective Drawing.

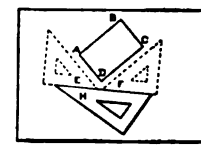
Tuition $30.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

ARITHMETIC PART II



FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definition; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

ARITHMETIC PART III

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight; Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

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INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

MECHANICAL DRAWING

PART I

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises in Line Work.

PART II

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

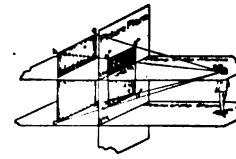
PART III

PROJECTIONS: Orthographic: Plan and Elevation: Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric; Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.

LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

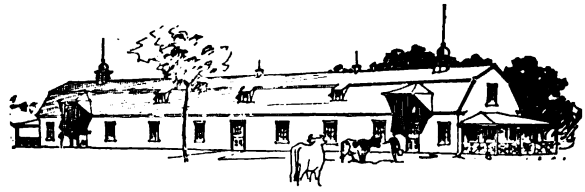
PERSPECTIVE DRAWING

THEORY AND DEFINITIONS: Station Point: Picture Plane; Ground Line; Horizon; Line of Measures; Axis; Vertical Trace, Horizontal Trace; Bird's-eye View; Worm's-eye View; Vanishing Point of Horizontal Lines; Vanishing Point of Vertical Lines; Vanishing Point of Oblique Lines.



PERSPECTIVE AND PROJECTIONS: Axioms; Planes; Notations; Problems Involving Points, Lines, Planes and Vanishing Points. Revolved Plan: Lines of Measure; Vanishing Points; Diagrams; Revolved Plan and Elevation; Systems of Lines and Planes: Visual Ray; Perspective Diagram.

PARALLEL OR ONE-POINT PERSPECTIVE: Method of Perspective Plan; Curves; Apparent Distortion, Choice of Position of Station Point. Plates.



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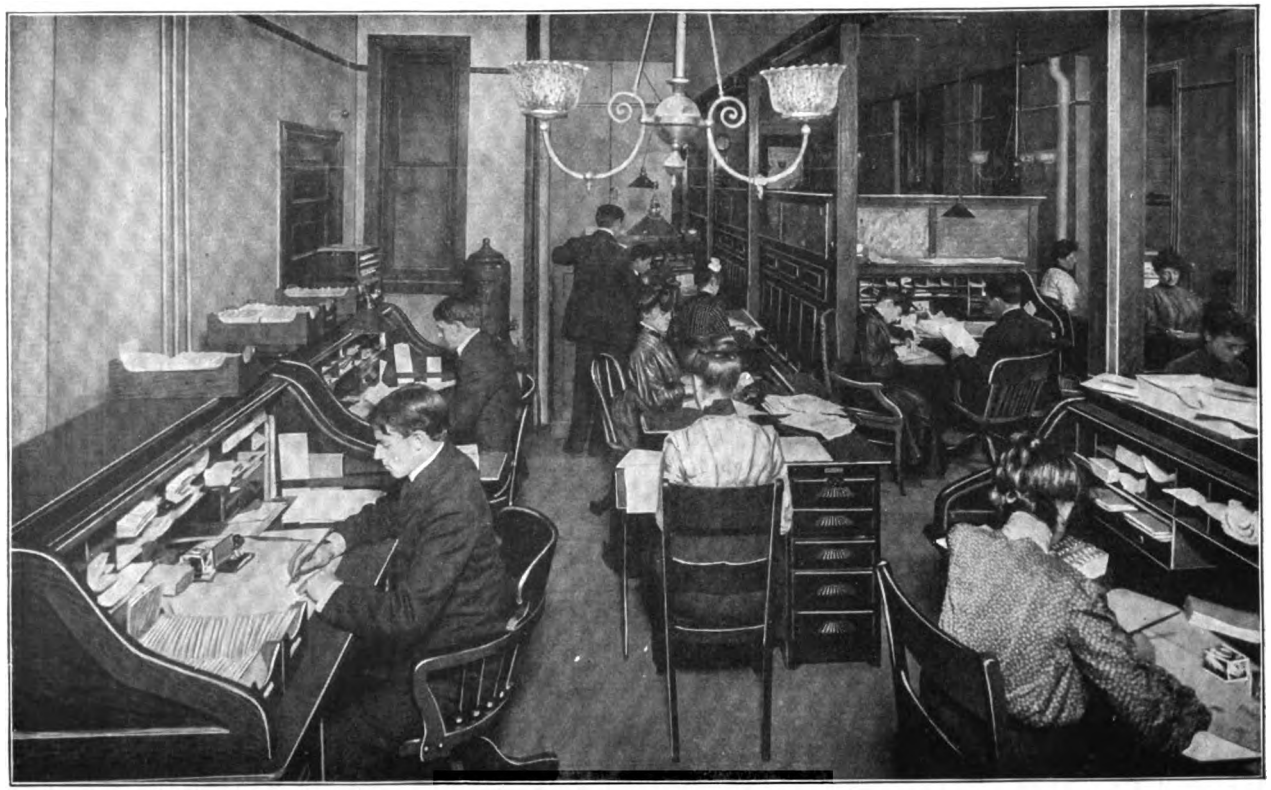

Corner of State Secretaries' Offices

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DEPARTMENT OF MATHEMATICS

COURSES

ELEMENTARY MATHEMATICAL
COMPLETE MATHEMATICAL
NAVIGATION

MATHEMATICS

OF all the sciences used by Engineers, Mechanics, Architects and those engaged in mercantile pursuits, Mathematics is by far the most important. The fundamental principles of Arithmetic and Geometry are so generally used that we are continually applying them unconsciously. The measuring and weighing of articles in trade, the making of change and the shortening of a walk by cutting across a field are common examples. The importance of Mathematics to technical men, especially Engineers and Architects, cannot be overestimated. The constant use of Arithmetic, Algebra and Geometry indicates this. While some branches of engineering can be followed and a certain degree of success attained with Elementary Mathematics, advanced work in Mathematics is exceedingly valuable and in many cases necessary. One should not attempt Civil Engineering without a good working knowledge of Trigonometry.

The instruction in Mathematics is made as practical as possible by omitting those subjects not pertaining to technical work and by selecting the data for the problems from actual engineering practice. Thus the instruction is of the greatest value to the mechanic. The Arithmetic begins with the fundamental processes and advances step by step so that one can readily master it. Among the subjects included in this department may be mentioned Arithmetic, Algebra, Geometry, Trigonometry and Logarithms.

Although the instruction in Mathematics is given separately it is intended primarily as a foundation to the engineering work.

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ELEMENTARY MATHEMATICAL

A short, practical course prepared for all classes of Wage-Earners, Students and those engaged in Mercantile and Mechanical Work.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.

Tuition $15.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

ARITHMETIC PART II

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation: Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

ARITHMETIC PART III

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight; Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

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Recording Department

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COMPLETE MATHEMATICAL

INSTRUCTION PAPERS IN THE COURSES

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Algebra Part I.
Algebra Part II.
Algebra Part III.
Algebra Part IV.
Graphs.
Plane Geometry.
Solid Geometry.
Trigonometry Part I.
Trigonometry Part II.
Logarithms.

Tuition $25.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

ARITHMETIC PART II

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction, Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

ARITHMETIC PART III

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight: Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

ALGEBRA PART I

EXPRESSIONS: Symbols; Coefficients and Exponents; Symbols of Relation; Symbols of Abbreviation; Positive and Negative Terms; Monomial; Binomial; Trinomial; Polynomials; Similar Terms. Finding Numerical Value by Substitution. Finding Values of Unknown Quantities.

FUNDAMENTAL PROCESSES: Addition; Subtraction; Use of Parentheses; Multiplication; Division; Formulae; Factoring; Highest Common Factor; Lowest Common Multiple.

FRACTIONS: Fractions and Integers; Reduction of Fractions to Lowest Terms; Reduction of Fractions to Entire or Mixed Quantities; Reduction of Mixed Quantities to Fractions; Reduction of Fractions to Lowest Common Denominator; Addition and Subtraction of Fractions; Multiplication and Division of Fractions; Complex Fractions.

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ALGEBRA PART II

SIMPLE EQUATIONS: Transposition; Solution of Simple Equations; Solution of Equations Containing Fractions; Literal Equations; Equations involving Decimals; Equations Containing Two Unknown Quantities: Elimination by Addition, Subtraction, Substitution and Comparison.

INVOLUTION AND EVOLUTION: Monomial and Polynomials; Squares, Cubes and Higher Powers. The Radical Sign; Theory of Exponents; Radicals; Reduction of Radicals.

ALGEBRA PARTS III AND IV

IMAGINARY QUANTITIES: Multiplication and Division of Imaginary Quantities. Quadratic Surds.

EQUATIONS: Solution of Equations Containing Radicals. Pure and Affected Quadratic Equations; Simultaneous Equations Involving Quadratics.

RATIO AND PROPORTION: Alternation; Inversion; Composition; Division.

PROGRESSION: Arithmetical and Geometrical.

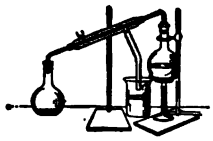
BINOMIAL THEOREM: Formulae; Positive Integers; Finding Terms in an Expansion.

GRAPHS

PROPOSITIONS: Graphs of Equations; Graphs in Physics; Graphs in General and Engineering Problems; Graphical Representation of Pure, Imaginary and Complex Numbers; Conic Sections; Simultaneous Quadratic Equations; Indeterminate Equations.

PLANE GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse, Complementary; Supplementary; etc. Parallel Lines; Axioms.



FUNDAMENTAL THEOREMS: Plane Figures; Polygons: Equilateral and Equiangular. Quadrilaterals; Circles; Measurements of Angles; Similar Figures; Trapezium; Trapezoid; Parallelogram; Rectangle; Square; Rhomboid; Rhombus. Ratio and Proportion. Terms; Alternation; Inversion; Composition and Division. The Circle: Theorems; Area; Circumference, etc.

SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons: Rectangles, Parallelograms, etc.

PROBLEMS OF CONSTRUCTION: Twenty-nine problems in Construction of Plane Figures.

SOLID GEOMETRY

PROPOSITIONS: Properties of Lines and Planes in Space; Solid Angles; Prisms; Pyramids; Cones; Cylinders; Spheres.

PROBLEMS: Lateral Areas; Total Areas and Volumes.

TRIGONOMETRY PART I

FUNCTIONS: Fundamental Theorems; Sine; Cosine; Tangent; Cotangent; Secant; Cosecant.

ANGLES: Functions of 0 degrees; 30 degrees; 45 degrees; 60 degrees; 90 degrees; 180 degrees; 270 degrees and 360 degrees.

TABLES: Trigonometric and Logarithmic; Nature and Use of Logarithms; Logarithms of a Product, Quotient, Power, Root. Solution of Right Triangles by Natural Functions and by Logarithms; Areas; Oblique Triangles.

PROBLEMS: Applications of Principles of Trigonometry to Heights, Distances and Areas. Practical Problems in Surveying and Physics.

TRIGONOMETRY PART II

FUNCTIONS: Angles with same Function or Functions; Graphical Representation; Unit Circle; Expression of one Function in Terms of each of the Others.

PROBLEMS: Trigonometric Equations; Applications to Mechanics; Identities; Laboratory Methods.

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NAVIGATION

A short, practical course prepared for Pilots, Captains, Steamboat Officers and those desiring positions on steam or sailing vessels.

INSTRUCTION PAPERS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Algebra Part I.
Algebra Part II.
Geometry.
Trigonometry and Logarithms.
Navigation.
Mechanical Drawing Part I.
Mechanical Drawing Part II.

Tuition $25.00. Payable Monthly.

SYNOPSIS OF COURSE

ARITHMETIC

SEE SYNOPSIS PAGE 166.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

ALGEBRA

EXPRESSIONS: Symbols; Coefficients and Exponents; Symbols of Relation; Symbols of Abbreviation; Positive and Negative Terms; Monomial; Binomial; Trinomial; Polynomials; Similar Terms. Finding Numerical Value by Substitution. Finding Values of Unknown Quantities.

FUNDAMENTAL PROCESSES: Addition; Subtraction; Use of Parentheses; Multiplication; Division; Formulae; Factoring; Highest Common Factor; Lowest Common Multiple.

FRACTIONS: Fractions and Integers; Reduction of Fractions to Lowest Terms; Reduction of Fractions to Entire or Mixed Quantities; Reduction of Mixed Quantities to Fractions; Reduction of Fractions to Lowest Common Denominator; Addition and Subtraction of Fractions; Multiplication and Division of Fractions; Complex Fractions.

SIMPLE EQUATIONS: Transposition; Solution of Simple Equations; Solution of Equations Containing Fractions; Literal Equations; Equations Involving Decimals; Equations Containing Two Unknown Quantities: Elimination by Addition, Subtraction, Substitution and Comparison.

INVOLUTION AND EVOLUTION: Monomials and Polynomials: Squares, Cubes and Higher Powers. The Radical Sign; Theory of Exponents; Radicals; Reduction of Radicals to Simplest Form; Addition, Subtraction, Multiplication and Division of Radicals. Involution and Evolution of Radicals. Irrational Denominators; Approximate Values.

IMAGINARY QUANTITIES: Multiplication and Division of Imaginary Quantities. Quadratic Surds.

EQUATIONS: Solution of Equations Containing Radicals. Pure and Affected Quadratic Equations; Simultaneous Equations Involving Quadratics.

RATIO AND PROPORTION: Alternation; Inversion; Composition; Division.

PROGRESSION: Arithmetical and Geometrical.

BINOMIAL THEOREM: Formulae; Positive Integers; Finding Terms in an Expansion.

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GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse Complementary; Supplementary; etc. Parallel Lines; Axioms.

FUNDAMENTAL THEOREMS: Plane Figures; Polygons: Equilateral and Equiangular. Quadrilaterals; Circles; Measurements of Angles; Similar Figures; Trapezium; Trapezoid; Parallelogram; Rectangle; Square; Rhomboid; Rhombus. Ratio and Proportion. Terms; Alternation; Inversion; Composition and Division. The Circle: Theorems; Area; Circumference, etc.

SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons: Rectangles, Parallelograms, etc.

PROBLEMS OF CONSTRUCTION: Twenty-nine problems in Construction of Plane Figures.

TRIGONOMETRY AND LOGARITHMS

TRIGONOMETRY: Definitions; Functions of Acute Angles; Measurement of Angles; Complementary Functions. Fundamental Theorems; Theorems Connecting the Different Functions of an Angle.

FUNCTIONS: From One Function of an Angle to Find the Other Functions. Functions of 45 degrees, 30 degrees and 60 degrees. Trigonometric Functions of Any Angle. Positive and Negative Angles; The Four Quadrants. Functions of 0 degrees, 90 degrees, 180 degrees and 270 degrees. Angles and Triangles.

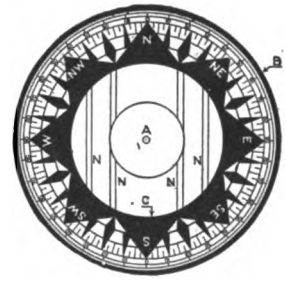
LOGARITHMS: Nature and Use of Logarithms; Logarithms of a Product, a Fraction, a Power, a Root. Solutions of Arithmetical Problems by Logarithms.

TRIANGLES: Right Triangles: Solution by Natural Functions; Solutions by Logarithms; Areas. Oblique Triangles: Solution by Breaking up into Right Triangles; Areas.

EXERCISES: Length of Belt over two Pulleys; Stress in Rods forming an Acute Angle.

NAVIGATION

DEFINITIONS: Sphere; Great Circle; Spherical Angle; Spherical Triangle; Meridians; Longitude; Parallels; Latitude; Departure; Knot; Rhumb Line.



THE COMPASS: Description; Boxing the Compass; Naming the Course; Magnetism; Dip of Needle; Variation; Deviation; Leeway. Courses: True Course; Compass Course. Charts: Mercator's Chart; Use of Charts; Scales of Longitude and Latitude; Ship's Position on Chart.

THE SAILINGS: Plain Sailing; Parallel, Traverse and Mercator's Sailings; Difference in Latitude; Difference in Longitude; Great Circle Sailing; Oblique Sailing; Navigating the Ship; Departure by Bearings and Distance; Shaping the Course; The Day's Work; Making the Land; Sounding; Taffrail Log.

LORD KELVIN ON NAVIGATION.

NAUTICAL ASTRONOMY: Definitions; The Sextant; The Vernier; True Altitude; Refraction; Parallax; Semidrameter; Finding Diameter. The Chronometer; Solar Time; Siderial Time; Astronomical and Civil Time; Nautical Almanac; Longitude at Sea by the Sun; Sumner's Method. Tides: Effect of Wind and Change of Air Pressure; Compass Deviation by Azimuth of the Sun.

MECHANICAL DRAWING

Part I

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises in Line Work.

Part II

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.

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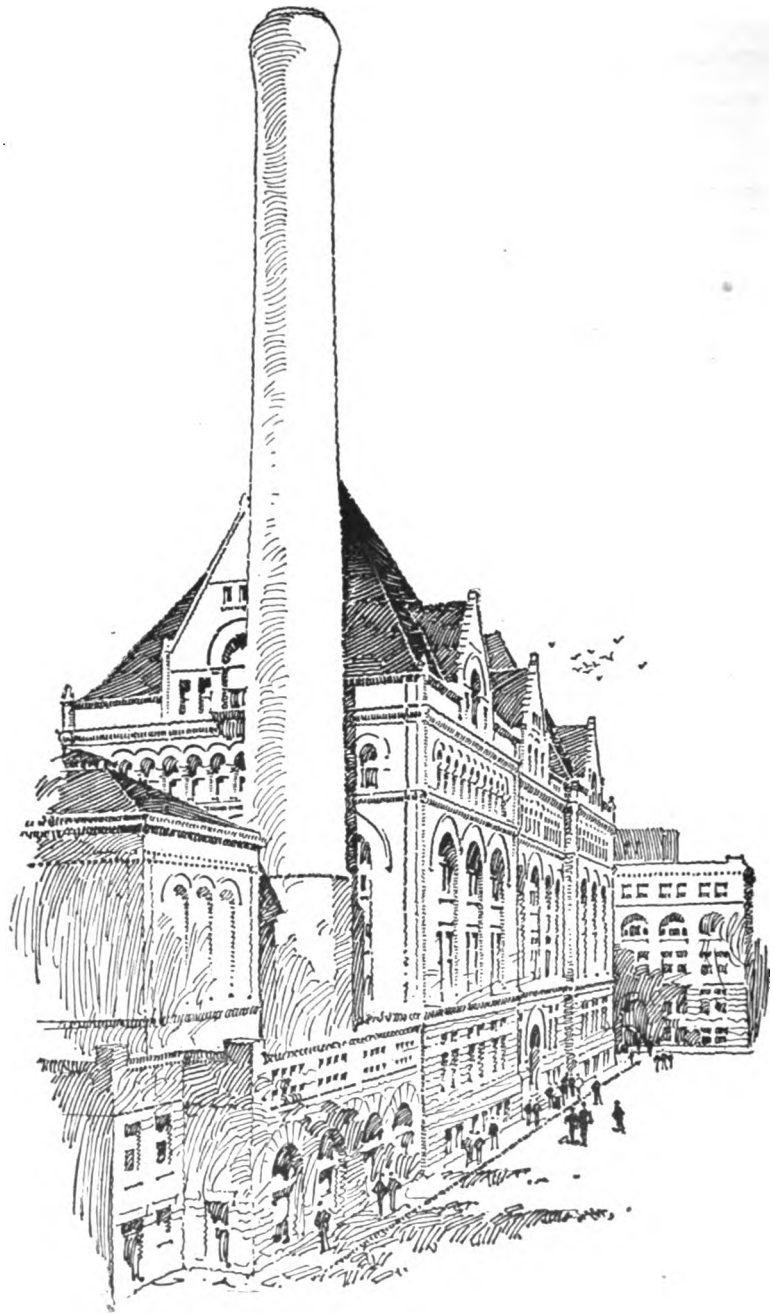

A STUDY IN PEN AND INK RENDERING.

By David A. Gregg. Author of Instruction Paper on Rendering in Pen and Ink.

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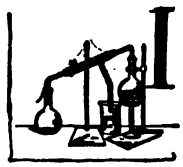
COLLEGE PREPARATORY DEPARTMENT

COURSES

COMPLETE PREPARATORY
MATHEMATICS
ENGLISH
GERMAN
UNITED STATES HISTORY
MECHANICAL DRAWING
PHYSICS
CHEMISTRY

COLLEGE PREPARATORY WORK



IT is a recognized fact that in practical life, as in intellectual life, success depends upon flexibility of mind and breadth of training. An intelligent study of the English language and literature, chemistry, physics, history, mathematics and modern languages, tends to develop the faculties and give the desired training. These subjects are taught thoroughly in the various colleges and universities.

Before entering a college or university, considerable preparation is necessary in the elementary branches; these studies are usually taken up under the direction of teachers in the preparatory schools. On account of adverse circumstances, distance from cities and lack of time, many who are desirous of entering college cannot spend four years at a preparatory school. For those who wish to obtain the training necessary to enter the College of Engineering at Armour Institute of Technology, or a similar institution, these courses have been prepared.

Students satisfactorily completing the course, as outlined, will be admitted to Armour Institute of Technology and similar institutions, without further examination in the studies pursued. These courses are also adapted to those who desire to fit themselves for teaching, banking, manufacturing or journalism.

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COMPLETE PREPARATORY COURSE

This course aims to give students desiring to enter technical schools or colleges the necessary preparation. It includes the subjects usually taught in high and preparatory schools.

SUBJECTS IN THE COURSE

Arithmetic Part I.
Arithmetic Part II.
Arithmetic Part III.
Elementary Algebra and Mensuration.
Algebra Part I.
Algebra Part II.
Algebra Part III.
Algebra Part IV.
Graphs.
Plane Geometry.
Solid Geometry.
Trigonometry Part I.
Trigonometry Part II.
Logarithms.
Mechanical Drawing Part I.
Mechanical Drawing Part II.
Mechanical Drawing Part III.
Mechanical Drawing Part IV.
Mechanical Drawing Part V.
Mechanical Drawing Part VI.
English Grammar and Rhetoric Lessons I-V.
English Grammar and Rhetoric Lessons VI-X.
English Grammar and Rhetoric Lessons XI-XV.
English Grammar and Rhetoric Lessons XVI-XX.
English Grammar and Rhetoric Lessons XXI-XXV.
English Grammar and Rhetoric Lessons XXVI-XXX.
English Grammar and Rhetoric Lessons XXXI-XXXV.
English Grammar and Rhetoric Lessons XXXVI-XL.
English Classics Part I.
English Classics Part II.
German Part I.
German Part II.
German Part III.
United States History (1492-1776).
United States History (1776-1783).
United States History (1783-1861).
United States History (1861-1903).
Elements of Chemistry.
General Chemistry Part I.
General Chemistry Part II.
General Chemistry Part III.
General Chemistry Part IV.
General Chemistry Part V.
General Chemistry Part VI.
General Chemistry Part VII.
Physics.

Tuition $75.00. Payable Monthly.

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SYNOPSIS OF COURSE

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers; Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

ARITHMETIC PART II

FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction, Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Divisions of Decimals; Symbols of Aggregation.

ARITHMETIC PART III

PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight; Liquid Measure; Dry Measure.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

ELEMENTARY ALGEBRA AND MENSURATION

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem; Measurement of Steam Space in a Horizontal Multitubular Boiler.

ALGEBRA PART I

EXPRESSIONS: Symbols; Coefficients and Exponents; Symbols of Relation; Symbols of Abbreviation; Positive and Negative Terms; Monomial; Binomial; Trinomial; Polynomials; Similar Terms. Finding Numerical Value by Substitution. Finding Values of Unknown Quantities.

FUNDAMENTAL PROCESSES: Addition; Subtraction; Use of Parenthesis; Multiplication; Division; Formulae; Factoring; Highest Common Factor; Lowest Common Multiple.

FRACTIONS: Fractions and Integers; Reduction of Fractions to Lowest Terms; Reduction of Fractions to Entire or Mixed Quantities; Reduction of Mixed Quantities to Fractions; Reduction of Fractions to Lowest Common Denominator; Addition and Subtraction of Fractions; Multiplication and Division of Fractions; Complex Fractions.

ALGEBRA PART II

SIMPLE EQUATIONS: Transposition; Solution of Simple Equations; Solution of Equations Containing Fractions; Literal Equations; Equations involving Decimals; Equations Containing Two Unknown Quantities: Elimination by Addition, Subtraction, Substitution and Comparison.

INVOLUTION AND EVOLUTION: Monomial and Polynomials; Squares, Cubes and Higher Powers. The Radical Sign; Theory of Exponents; Radicals; Reduction of Radicals.

ALGEBRA PARTS III AND IV

IMAGINARY QUANTITIES: Multiplication and Division of Imaginary Quantities. Quadratic Surds.

EQUATIONS: Solution of Equations Containing Radicals. Pure and Affected Quadratic Equations; Simultaneous Equations Involving Quadratics.

RATIO AND PROPORTION: Alternation; Inversion; Composition; Division.

PROGRESSION: Arithmetical and Geometrical.

BINOMIAL THEOREM: Formulae; Positive Integers; Finding Terms in an Expansion.

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GRAPHS

PROPOSITIONS: Graphs of Equations; Graphs in Physics; Graphs in General and Engineering Problems; Graphical Representation of Pure, Imaginary and Complex Numbers; Conic Sections; Simultaneous Quadratic Equations; Indeterminate Equations.

PLANE GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse, Complementary; Supplementary; etc. Parallel Lines; Axioms.

FUNDAMENTAL THEOREMS: Plane Figures; Polygons: Equilateral and Equiangular. Quadrilaterals; Circles; Measurements of Angles; Similar Figures; Trapezium; Trapezoid; Parallelogram; Rectangle; Square; Rhomboid; Rhombus. Ratio and Proportion. Terms; Alternation; Inversion; Composition and Division. The Circle: Theorems; Area; Circumference, etc.

SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons: Rectangles, Parallelograms, etc.

PROBLEMS OF CONSTRUCTION: Twenty-nine problems in Construction of Plane Figures.

SOLID GEOMETRY

PROPOSITIONS: Properties of Lines and Planes in Space; Solid Angles; Prisms; Pyramids; Cones; Cylinders; Spheres.

PROBLEMS: Lateral Areas; Total Areas and Volumes.

TRIGONOMETRY PART I

FUNCTIONS: Fundamental Theorems; Sine; Cosine; Tangent; Cotangent; Secant; Cosecant.

ANGLES: Functions of 0 degrees; 30 degrees; 45 degrees; 60 degrees; 90 degrees; 180 degrees; 270 degrees and 360 degrees.

TABLES: Trigonometric and Logarithmic; Nature and Use of Logarithms; Logarithms of a Product, Quotient, Power, Root. Solution of Right Triangles by Natural Functions and by Logarithms; Areas; Oblique Triangles.

PROBLEMS: Applications of Principles of Trigonometry to Heights, Distances and Areas. Practical Problems in Surveying and Physics.

TRIGONOMETRY PART II

FUNCTIONS: Angles with same Function or Functions; Graphical Representation; Unit Circle; Expression of one Function in Terms of each of the Others.

PROBLEMS: Trigonometric Equations; Applications to Mechanics; Identities; Laboratory Methods.

MECHANICAL DRAWING

Part I

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates; Exercises in Line Work.

Part II.

GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustums; Spheres, Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-eight Problems in Geometrical Drawing.

Part III

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments; Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light.

LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.

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Part IV

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crosshatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads. Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for Solutions for Blue-Print Paper. Plates.

Part V

DETAILED DRAWINGS: The Helix; Pitch; Springs; Conventional Representations; V-Thread; Square Thread; Standard Threads. Cams: Kinds of Motion; Kinds of Cams; Designing.

GEARING: Belt: Parallel Shafts; Open and Crossed Belts; Quarter-Turn Belt; Reversible Quarter-Turn Belt with Two Guide Pulleys; With One Guide Pulley. Belts Connecting Non-Parallel Shafts whose Axes Intersect. Belt Holes. Tooth Gearing: Pitch Circles; Addendum; Back Lash; Diametrical Pitch; Cycloidal and Involute Gears; Epicycloidal Spur Gears. Annular Gears; Rack and Pinion; Involute Gears; Bevel Gears. Plates.

Part VI

WORKING SHOP DRAWINGS: Plan and Scope of Advanced Work; Essentials; Completeness of Drawings; Cost of Producing; Method of Procedure.

DUPLEX PUMP PLATES: Rating of Pump; Steam-End Layout; Molding and Machining of Steam End. Dimensions and Letters; System; Accuracy; Clearness; Completeness; Character; Inking and Tracing; Dimensions; Abbreviations; Piston Rod and Valve Stem; Molding and Machining; Steam Chest and Valve; Valve-Motion Layout and Details; Yoke; Stuffing Boxes; Brackets; Water-end Layout; Water Cylinder; Cap; Air Chamber; Plunger; Valve Details; Foundation; General Drawing.

ORDER SHEETS: List of Castings and Miscellaneous Parts; Bolts; Nuts; Pins; Special Fittings; Wrenches.

PLATES; Details; Assembly Drawing of Pump; Tracing.

ENGLISH

The work in English is planned to aid the student in expressing his thoughts clearly and correctly, in developing an appreciation of the best literature and in cultivating a taste for the best reading. It covers the three years work of the Scientific Academy of Armour Institute of Technology.

GRAMMAR: Sentences: Declarative; Imperative; Interrogative; Simple; Complex; Compound. Analysis. The Proposition; Subject; Predicate; Punctuation; Use of Capital Letters. Noun Clauses. Parts of Speech: Noun; Pronoun; Verb; Preposition; Conjunction; Adjective; Adverb; Interjection; Participle; Inflection; Conjugation of Verbs; Number and Case of Nouns and Pronouns; Comparison of Adjectives; Parsing; Modifiers; Connectives; Correlatives.

COMPOSITION: Arrangement of Words in Sentence; Spelling; Exercises in Punctuation; Original Work in Composition a constant requirement; Cultivation of Imagination; Rhetorical Structure of Sentence; Unity; Clearness; Ease; Force; Antithesis; Redundant Words; Vocabulary; Committing to Memory; Slang; The Paragraph; The Topic Sentence; Relation of Sentences in Paragraph; Development of Topic Sentence; Repetition; Details; Illustration; Specific Instances; Comparisons; Contrast; Definition; Cause and Effect; Proofs; Combination of Two or More Methods; Rewriting Paragraphs for Special Effects; Indention; Letter Writing; Correction of Faulty Sentences; Filling in Outline of a Story; Composition as a Whole; Selection of Materials; Unity; Coherence; Proportion; Climax.

LITERATURE: The instruction in Literature is based upon the classics. These classics have been selected by a conference of professors of the leading colleges and secondary schools, beause they represent the different types of literary art and the different periods of literary history. They are to be read with reference to both subject matter and style. The instruction paper gives for each book, an explanation of its type of literary art, an account of its place in the history of English Literature, suggestions for the study of the text, comments, and detailed explanation. Topics for essays on each of the books for careful study are given.

BOOKS FOR GENERAL READING

Scott: Ivanhoe.
George Eliot: Silas Marner.
Shakespeare: Julius Caesar and The Merchant of Venice.
Goldsmith: Vicar of Wakefield.
Coleridge: Rime of the Ancient Mariner.
Carlyle: Essays on Burns.
Lowell: Vision of Sir Launfal.
Tennyson: The Princess.
Addison: The Sir Roger de Coverley Papers.

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BOOKS FOR CAREFUL STUDY

Shakespeare: Macbeth.
Milton: Lycidas, Comus, L'Allegro and Il Penseroso.
Macaulay: Essays on Milton and Addison.
Burke: Speech on Conciliation with America.

GERMAN

The work in German is planned to give the student a fair reading knowledge of the language, and a large vocabulary. Careful study is given the structure of the language, essentials of accidence and syntax, and translation.

The instruction is based upon standard text-books, furnished the student, and is divided into three parts, each corresponding to one term's work in the Scientific Academy of Armour Institute of Technology.

Each part is composed of a number of sections consisting of:

1. Directions for studying the Grammar.
2. Supplementary drill exercises.
3. Directions and advice regarding the use of the reader.
4. Review questions and exercises.

A certain number of pages in the Reader are to be taken in connection with each section.

Frequent reviews are given, and a thorough examination required on each part.

PART I. Alphabet; Pronunciation; Definite and Indefinite Articles; Nouns; Pronouns; Present and Past Indicative of Strong and Weak Verbs; Order of Words; Prepositions.

PART II. Adjectives; Pronominal Words; Numerals; Verbs (Active Voice); Irregular Weak Verbs; Irregular or Mixed Nouns.

PART III. Modal Auxiliaries; Compound Verbs with Prefixes; Verbs (Passive Voice); Reflexive and Impersonal Verbs; Subjunctives.

TEXT-BOOKS:—

Bierwirth, Beginning German, Grammar.
Schrakamp and Van Daell, Das Deutsche Buch, Reader, For Parts I and II.
Schrakamp, Exercises in Conversational German, Reader, For Part III.

UNITED STATES HISTORY

The work in United States History is based upon "McMaster's History of the United States" and is divided into four parts, each covering thoroughly an important period. Numerous suggestions, comments, and explanations are given. A thorough examination on each part is required.

COLONIAL PERIOD: Voyage and Discovery; Colonization; Intercolonial Wars; Social and Political Institutions; Growth of Liberty and Union.

FORMATION OF THE UNION: Causes of the Revolution; Principal Events; Results of the Revolution; The Articles of Confederation; The Federal Convention; The Constitution.

NATIONAL EXPANSION: Hamilton's Financial Policy; The War of 1812; Territorial Growth; The Bank Question; The Tariff; The Slavery Question.

DIVISION AND REUNION: Causes of the Civil War; Leaders; Chief Events; Reconstruction; Civil Service Reform; Political Parties; Scientific and Industrial Progress.

CHEMISTRY

The instruction in Chemistry is based on Remsen's College Chemistry. In addition to this text book, the student receives an Instruction Paper on Elements of Chemistry and a Combination Laboratory Manual and Note Book. The laboratory work is covered in 145 experiments.

The apparatus and materials necessary for these experiments are furnished the student at cost ($17.50). Among the items are the following:

Bunsen Burner or	Rubber Tubing	Crucibles
Alcohol Lamp	Flasks	Liebig Condenser
Test Tubes	Mortar and Pestle	Beakers
Evaporating Dish	Thistle Tube	Burettes
Pneumatic Trough	Ignition Tubes	Blow Pipe
Glass Tubing	Glass Retort	Retort Stand

In addition, there are the various acids, bases, salts, metals, and other materials.

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PHYSICAL CHANGE AND CHEMICAL CHANGE: Experiments with Platinum, Copper and Magnesium Wire; Application of Heat to Sugar; Iron Filings and Sulphur; Hydrochloric Acid and Marble; Acids on Metals.

GASES: Pneumatic Trough; Effect of Changes of Temperature and Pressure on Volume; Coefficient of Expansion of Gases.

HYDROGEN: Preparation by use of Sodium and Potassium; By decomposition of Water by an Electric Current; By Sulphuric Acid and Iron Filings; By zinc and Hydrochloric Acid. Formation of water from Hydrogen and Oxygen. Physical and Chemical Properties and Uses of Hydrogen.

OXYGEN: Oxygen Made from Potassium Chlorate; Properties of Oxygen; Combustion; Experiments with Sulphur and Sodium in Oxygen; Steel burned in Oxygen. Products of Combustion. Nature of Combustion.

WATER: Water in Mineral, Animal and Vegetable Substances; Evaporation and Distillation. Purification of water containing solids dissolved; containing gases dissolved; Ionization by Water. Electric conductivity of solutions; Solubility of Salts in water; Distilled Water; Solution of Sodium Hydroxide; Solution of Hydrogen Chloride.

CHEMICAL COMBINATION: Law of Definite Proportions; Neutralization of Acids and Bases. Law of Multiple Proportion.

NITROGEN: Experiment with Phosphorus and Air. Constituents of Air; Properties of Nitrogen; Ammonium Nitrate; Affinity of Hydrogen, Oxygen and Nitrogen for each other. Ammonia; Aqua Ammonia; Properties; Effect on Acids; Sources; Neutralization; Stability of Ammonium Salts. Oxides of Nitrogen; Formula for Nitric Acid. Nitric Acid; Manufacture; Action on Animal and Vegetable Fibers. Formation of Nitrates from Nitric Acid and Metals. Nitrates: Composition of Explosives; Action of Heat on Nitrates; Solubility of Nitrates.

PHOSPHORUS: Characteristic Properties; Spontaneous Combustion; Chemical Activity; Differences in the Properties of Yellow and Red Phosphorus. Phosphine: Preparation; Composition; Properties. Oxides and Acids of Phosphorus; Phosphorus Pentoxide; Preparation of Acids. Phosphorus Acid: Tests: Comparison with other Acids.

ARSENIC: Properties: Melting and Burning Points; Test for Arsenic; Valence.

ANTIMONY: Comparison of Antimony and Aresenic.

BISMUTH: Comparison of Phosphorus, Arsenic, Antimony and Bismuth as to Specific Gravity, Tendency to Burn in Air and to Form Acids. Review of Nitrogen Group.

SULPHUR: Formation of Crystals; States of Sulphur—Solid; Liquid; Gas. Hydride of Sulphur; Effect of Hydrogen Sulphide on Zinc Sulphate, Arsenic Trioxide, Copper Sulphate, Tartar Emetic, Lead Nitrate and Iron Sulphate. Making Sulphuric Acid.

THE HALOGENS: Hydrofluoric Acid Gas: Action on Glass: Chlorine: Tests; Affinity of Chlorine for Hydrogen; Bleaching Power; Preparation of Potassium Chlorate. Hydrochloric Acid. Preparation of Chloric Acid. Bromine. Comparison of Bromine and Chlorine. Iodine.

CARBON: Properties; Uses of Animal Charcoal; Oxides of Carbon; Carbon Dioxide; Combustion; Calcium Carbonate; Soap Solutions and Hard Waters; Asphyxiation; Flames: Bunsen Burner; Characteristics of salts in general.

METALS AND THEIR SALTS: Sodium and Potassium Compound; Properties; Tests. Copper Compounds; Magnesium, Calcium, Strontium and Barium. Zinc, Cadmium and Mercury. Aluminum. Tin and Lead. Chromium and Molybedenum. Manganese. Iron, Cobalt and Nickel.

PHYSICS

This course follows closely that given in the University High School of the University of Chicago, Millikan's and Gale's "First Course in Physics" being used as the reference text. An outfit of laboratory apparatus is supplied to each student, on the conditions stated below, together with complete directions for the performance of about 50 experiments, which are carefully selected to illustrate and emphasize all of the most important principles underlying the various branches of Physics.

The course has been developed by, and will be under the supervision of, Robert Andrews Millikan, Ph. D., Assistant Professor of Physics in the University of Chicago, and Glenn M. Hobbs, Ph. D., in charge of the Department of Physics, School of Educaton, University of Chicago.

A very complete outfit of apparatus will be loaned the student upon a deposit of $10.00 and a guarantee that the outfit will be returned at the end of six months. The deposit will be refunded, less breakage, upon return of the outfit.

SPECIAL COURSES

MATHEMATICS, MECHANICAL DRAWING, ENGLISH, GERMAN, UNITED STATES HISTORY, CHEMISTRY, PHYSICS. (For synopses, see pages 161-165.)

Tuition $25.00. Payable Monthly.

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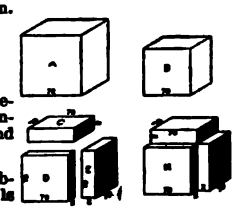
GENERAL STUDIES

Preliminary to Engineering Courses

ARITHMETIC PART I

FUNDAMENTAL PROCESSES: Units; Numbers: Concrete and Abstract; Like and Unlike. Notation; Numeration; Value; Arabic and Roman Numerals; Addition; Subtraction; Multiplication; Division; Factoring; Cancellation.

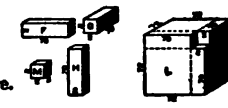
ARITHMETIC PART II



FRACTIONS: Definitions; Proper and Improper Fractions; Reduction of Fractions; Least Common Multiple; Least Common Denominator; Addition, Subtraction; Multiplication and Division of Fractions.

DECIMALS: Definitions; System of Notation; Addition, Subtraction, Multiplication and Division of Decimals; Symbols of Aggregation.

ARITHMETIC PART III



PERCENTAGE: Definitions; Decimals; Fractions and Percentage. Percentage; Rate; Base. Gain or Loss; Rules.

DENOMINATE NUMBERS: Reduction of Denominate Numbers; Linear Measure; Square Measure; Cubic Measure; Measures of Weight: Avoirdupois; Troy; Apothecaries'; Surveyors' Measure; Liquid Measure; Dry Measure; Measures of Money; Measures of Time. Operations with Denominate Numbers.

INVOLUTION AND EVOLUTION: Exponents; Powers; Radical Sign; Square Root; Cube Root. Roots of Fractions; Roots other than Square and Cube.

RATIO AND PROPORTION: Antecedent; Consequent; Extremes and Means; Rules for Solving Examples in Simple Proportion.

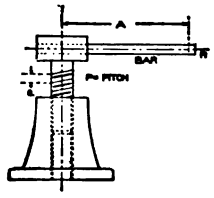
ELEMENTARY ALGEBRA AND MENSURATON

ALGEBRA: Use of Letters; Addition; Subtraction; Multiplication; Division. Cancellation; Simple Equations; Transposition; Substituting in Equations and Formulas; Finding Values of Unknown Quantities.

MENSURATION: Definitions: Lines; Angles; Polygons; Circles; Sectors; Segments; Measurement of Angles, Triangles, Rectangles, Trapezoids, Hexagons, Circles. Volumes and Surfaces of Prisms, Cylinders, Pyramids, Cones, Frustums of Cones and Pyramids. Sphere. Practical Problem: Measurement of Steam Space in a Horizontal Multitubular Boiler.

MECHANICS PART I

PROPERTIES OF MATTER: Atoms and Molecules; Solids; Liquids; Gases; Extensibility; Impenetrability; Indestructibility; Inertia; Divisibility; Porosity; Hardness; Tenacity; Brittleness; Malleability; Ductility.



MOTION, VELOCITY AND FORCE: Momentum; Newton's Laws; Parallelogram of Forces; Force Diagrams. Center of Gravity; Falling Bodies; Projectiles; The Pendulum; Kinetic and Potential Energy; Centrifugal Force.

PRINCIPLES OF MACHINES: Levers; Pulleys; Inclined Planes; Wedges; Screws; Laws of Friction; Coefficients of Friction. Tooth Gears: Spur; Worm; Bevel; Helical; Belt, Wire and Rope Gearing. Velocity Ratio; Horse Power Transmitted; etc.

MECHANICS PART II

STRENGTH OF MATERIALS: Cohesion; Adhesion; Capillarity; Stress; Deformation; Elastic Limit; Breaking Strength; Coefficient of Elasticity; Tension; Compression; Shear; Torsion; Factor of Safety; Working Stress. Strength of Pipes and Cylinders; Strength of Beams and Columns; Moment of Inertia; Diagrams and Formulas.

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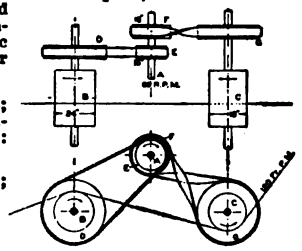
HYDROSTATICS: Density; Specific Gravity; Hydrometers; Pressure of Fluids; Hydraulic Press; Head; Pressure; Dams and Gates; Coefficients of Flow; Water Motors; Turbines.

PNEUMATICS: Barometers; Mariotte's Law; Suction Pumps.

MECHANISM

REVOLVING BODIES: Mechanism; Motion; Velocity; Surface Speed; Calculation for Diameter and Number of Revolutions; Cylinder and Cones in direct Contact. Cylinders and Cones Connected by Belts; Stepped and Tapered Cones. Disc and Roller. Tight and Loose Pulleys; Clutches; Other Mechanisms.



SIMPLE MACHINE PARTS: Screws; Levers; Cams; Linkwork; Motion and Power; Applications for Machine Shop and Textile Work. Quick Return Motions: Whitworth; Swinging Block.

GEARS: Spur; Annular; Bevel; Worm and Wheel; Velocity Ratios; Trains of Gears.

HEAT

DEFINITION AND NOTATION: Definition of Heat; Amount of Heat; Degree of Heat; Thermometer: Temperature; Fahrenheit; Centigrade; Reaumur. Freezing and Boiling Points. Notation: Absolute Temperature; Changing from one Scale to another.

HEAT EFFECTS: Expansion: Cubical; Linear; Coefficients of Expansion; Expansion of Solids, Liquids and Gases. Liquefaction: Laws of Fusion; Table of Melting Points; Vaporization; Evaporation; Boiling; Table of Boiling Points; Boiling under Pressure and in Vacuum. Distillation; Conduction; Convection; Radiation.

THERMODYNAMICS: Mechanical Equivalent of Heat; First Law; Adiabatic and Isothermal Expansion; Second Law; The Heat Engine.

PRACTICAL APPLICATIONS: The Steam Engine and Hot-Air Engine; Manufacture of Ice; Production of Liquid Air.

ELEMENTS OF CHEMISTRY

FUNDAMENTAL PRINCIPLES: Physical and Chemical Changes; Mechanical Mixture; Molecules and Atoms.

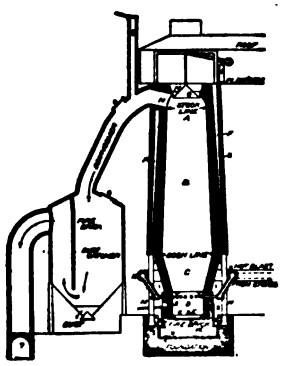
ELEMENTS: Table of Elements with Symbols, etc. Atomic Weight; Vapor Density; Law of Definite Weight; Valence; Combining Value. Equations, Factors and Products. Saturated Solution.

PROPERTIES: Physical and Chemical Properties of Oxygen; Hydrogen; Nitrogen. Chemistry of Air and Water; Carbon: Forms and Compounds. Illuminating Gas; Water Gas; Coal Gas; Composition. Combustion; Carbon Monoxide; Carbon Dioxide.

METALS: Sodium: Properties; Compounds. Calcium: Properties; Compounds.

ACIDS: Manufacture of Sulphuric, Nitric and Hydrochloric Acids.

METALLURGY



IRON AND STEEL: Ores: Magnetite; Hematite; Limonite; Siderite. Minerals: Iron Pyrites; Franklinite. Preparation of Ores.

BLAST FURNACE: Ores; Flux; Fuel; Slag. Operation and Chemistry of Furnace. Cast Iron: Grades and Impurities. Malleable Cast Iron.

WROUGHT IRON: Direct Process; Puddling Process; Operation of Furnace. Welding.

STEEL: Blister Steel; Crucible Steel; Bessemer Process: Converter; Acid and Basic Bessemer; Cupola Process; Molds and Molding. Rails. Open Hearth Process: Martin Process; Siemens Process, Combination; Gas Producers. Special Steels; Casehardening: Effects of Elements in Steel; Tempering: Colors and Temperature.

OTHER METALS: Copper: Ores; Extraction; Smelting; Refining. Lead: Smelting; Softening and Desilverizing; Refining. Tin. Zinc. Aluminum. Tables of Properties of Metals and Alloys.

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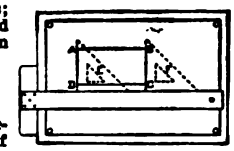
MECHANICAL DRAWING

PART I

INSTRUMENTS AND MATERIALS: Drawing Paper; Board; Pencils; T-Squares; Triangles; Compasses; Line Pens; Scales; Irregular Curves; Lettering Plates: Exercises in Line Work.

PART II

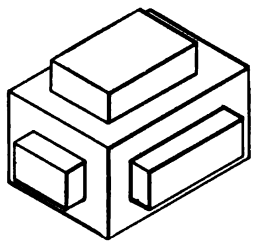
GEOMETRICAL DRAWING: Lines; Angles; Triangles; Quadrilaterals; Parallelograms; Rhombus; Pentagon; Hexagon; Circles; Measurement of Angles. Solids: Prisms; Pyramids; Cylinders; Cones; Frustrums; Spheres. Ellipse; Parabola; Hyperbola; Cycloid and Involute Curves. Plates: Twenty-Eight Problems in Geometrical Drawing.



PART III

PROJECTIONS: Orthographic: Plan and Elevation; Projection of Points, Lines, Surfaces and Solids. Third Plane of Projection; True Length; Shade Lines; Light and Dark Surfaces. Intersections and Developments: Intersections of Planes with Cones and Cylinders; Development of Prisms, Cylinders, Cones, etc. Development of Elbow. Isometric: Isometric Axes; Cube; Cylinder; Directions of Rays of Light. Plan and Elevation of Pentagonal Pyramid. Vertical and Horizontal Projections. Oblique Projections: Difference between Oblique Projection and Isometric. Shade Lines; Coordinates. Isometric of House, Box, etc. Oblique Projection of Crank Arm.

LINE SHADING AND LETTERING: Gradations of Light and Shade on Curved Surfaces; Shading Cylinders, Cones, Spheres, etc. Sizes and Spacing of Letters; Gothic and Roman Alphabets; Architectural Letters; Titles for Working Drawings. Plates.



PART IV

WORKING DRAWINGS: Lines: Full; Invisible; Shade; Center; Extension; Dimension. Location of Views; Cross Sections; Crossbatching; Dimensions; Finished Surfaces; Material; Conventional Representations of Screw Threads, Bolts and Nuts. Methods of Drawing Hexagonal and Square Nuts. Threads in Sectional Pieces; Broken Shafts, Columns, etc. Tables of Standard Screw Threads, Bolts and Nuts. Scale Drawing; Assembly Drawing; Blue Printing; Formulas for Blue-Print Paper. Plates.
Plates.

PART V

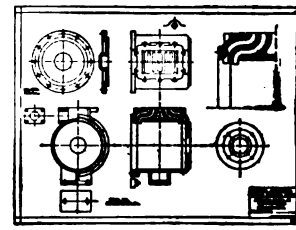
DETAILED DRAWINGS: The Helix; Pitch; Springs; Conventional Representations; V-Thread; Square Thread; Standard Threads. Cams: Kinds of Motion; Kinds of Cams; Designing.

GEARING: Belt: Parallel Shafts; Open and Crossed Belts; Quarter-Turn Belt; Reversible Quarter-Turn Belt with Two Guide Pulleys; With One Guide Pulley. Belts Connecting Non-Parallel Shafts whose Axes Intersect. Belt Holes. Tooth Gearing: Pitch Circles; Addendum; Back Lash; Diametrical Pitch; Cycloidal and Involute Gears; Epicycloidal Spur Gears. Annular Gears; Rack and Pinion; Involute Gears; Bevel Gears. Plates.

PART VI

WORKING SHOP DRAWINGS: Plan and Scope of Advanced Work; Essentials; Completeness of Drawings; Cost of Producing; Method of Procedure.

DUPLEX PUMP PLATES: Rating of Pump; Steam-End Layout; Molding and Machining of Steam End. Dimensions and Letters; System; Accuracy; Clearness; Completeness; Character; Inking and Tracing: Dimensions; Abbreviations; Piston Rod and Valve Stem; Molding and Machining; Steam Chest and Valve; Valve-Motion Layout and Details; Yoke; Stuffing Boxes; Brackets; Water-end Layout; Water Cylinder; Cap; Air Chamber; Plunger; Valve Details; Foundation; General Drawing.



ORDER SHEETS: List of Castings and Miscellaneous Parts: Bolts; Nuts; Pins; Special Fittings; Wrenches.

PLATES: Details; Pencil Drawings and Inked Plates; Assembly Drawing of Pump: Tracing.

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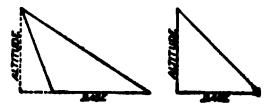
MATHEMATICS

ALGEBRA PART I

EXPRESSIONS: Symbols; Coefficients and Exponents; Symbols of Relation; Symbols of Abbreviation; Positive and Negative Terms; Monomial; Binomial; Trinomial; Polynomials; Similar Terms. Finding Numerical Value by Substitution. Finding Values of Unknown Quantities.

FUNDAMENTAL PROCESSES: Addition; Subtraction; Use of Parentheses; Multiplication; Division; Formulae; Factoring; Highest Common Factor; Lowest Common Multiple.

FRACTIONS: Fractions and Integers; Reduction of Fractions to Lowest Terms; Reduction of Fractions to Entire or Mixed Quantities; Reduction of Mixed Quantities to Fractions; Reduction of Fractions to Lowest Common Denominator; Addition and Subtraction of Fractions; Multiplication and Division of Fractions; Complex Fractions.



ALGEBRA PART II

SIMPLE EQUATIONS: Transposition; Solution of Simple Equations; Solution of Equations Containing Fractions; Literal Equations; Equations Involving Decimals; Equations Containing Two Unknown Quantities: Elimination by Addition, Subtraction, Substitution and Comparison.

INVOLUTION AND EVOLUTION: Monomials and Polynomials: Squares, Cubes and Higher Powers. The Radical Sign; Theory of Exponents; Radicals; Reduction of Radicals to Simplest Form; Addition, Subtraction, Multiplication and Division of Radicals. Involution and Evolution of Radicals. Irrational Denominators; Approximate Values.

IMAGINARY QUANTITIES: Multiplication and Division of Imaginary Quantities. Quadratic Surds.

EQUATIONS: Solution of Equations Containing Radicals. Pure and Affected Quadratic Equations; Simultaneous Equations Involving Quadratics.

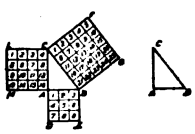
RATIO AND PROPORTION: Alternation; Inversion; Composition; Division.

PROGRESSION: Arithmetical and Geometrical.

BINOMIAL THEOREM: Formulae; Positive Integers; Finding Terms in an Expansion.

GEOMETRY

DEFINITIONS: Principles; Axioms; Abbreviations. Angles: Acute; Obtuse Complementary; Supplementary; etc. Parallel Lines; Axioms.



FUNDAMENTAL THEOREMS: Plane Figures; Polygons: Equilateral and Equiangular. Quadrilaterals; Circles; Measurements of Angles; Similar Figures; Trapezium; Trapezoid; Parallelogram; Rectangle; Square; Rhomboid; Rhombus. Ratio and Proportion. Terms; Alternation; Inversion; Composition and Division. The Circle: Theorems; Area; Circumference, etc.

SIMILAR POLYGONS: Definitions. Theorems. Areas of Miscellaneous Figures; Equivalent Polygons: Rectangles, Parallelograms.

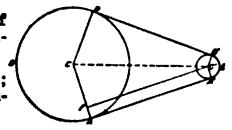
PROBLEMS OF CONSTRUCTION: Twenty-nine Problems in Construction of Plane Figures.

TRIGONOMETRY AND LOGARITHMS

TRIGONOMETRY: Definitions; Functions of Acute Angles; Measurement of Angles; Complementary Functions. Fundamental Theorems; Theorems Connecting the Different Functions of an Angle.

FUNCTIONS: From One Function of an Angle to Find the Other Functions. Functions of 45 degrees, 30 degrees and 60 degrees. Trigonometric Functions of Any Angle. Positive and Negative Angles; The Four Quadrants. Functions of 0 degrees, 90 degrees, 180 degrees and 270 degrees. Angles and Triangles.

LOGARITHMS: Nature and Use of Logarithms; Logarithms of a Product, a Fraction, a Power, a Root. Solutions of Arithmetical Problems by Logarithms.



TRIANGLES: Right Triangles: Solution by Natural Functions; Solutions by Logarithms; Areas. Oblique Triangles: Solution by Breaking up into Right Triangles; Areas.

EXERCISES: Length of Belt over two Pulleys; Stress in Rods forming an Acute Angle.

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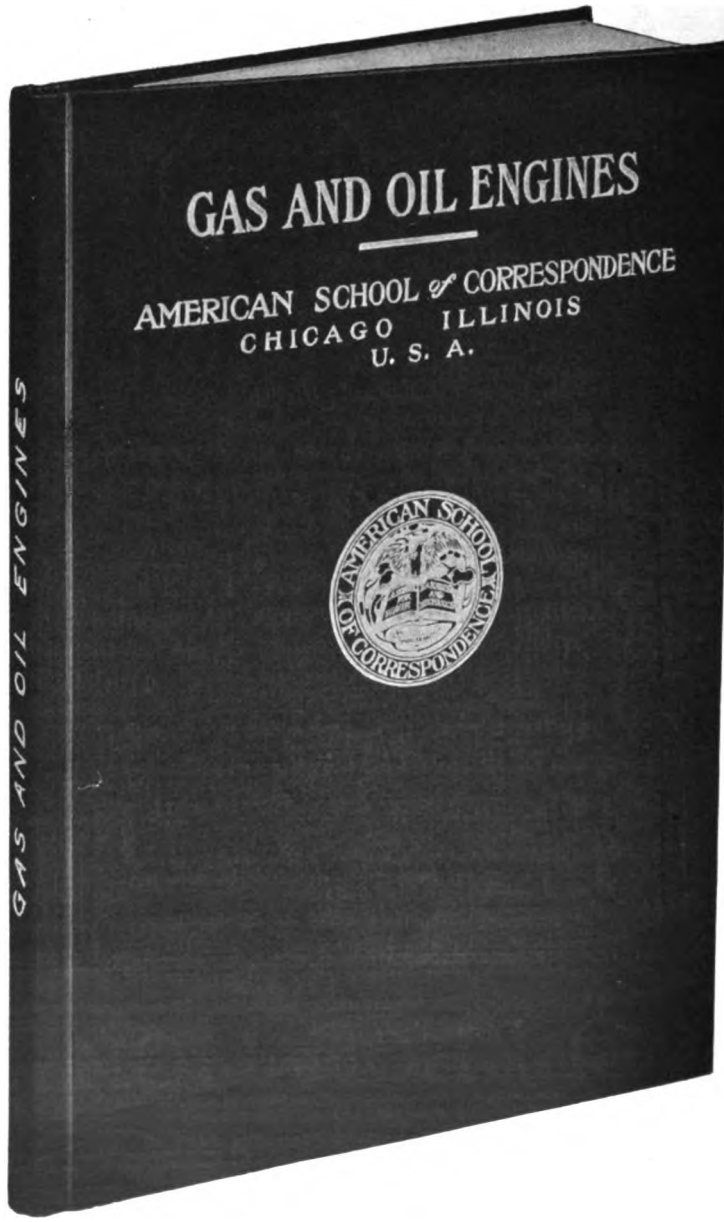

SPECIMEN INSTRUCTION BOOK

Of which there are about Fifty in every Full Course, each averaging Eighty Pages, handsomely bound in cloth.

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APPRECIATION

AS an evidence of the high esteem in which the work of the American School of Correspondence is held by other Educational Institutions, we append the names of a few of the leading Universities, Colleges, etc., in which various Instruction Papers of the School have been adopted as regular text-books.

Massachusetts Institute of Technology, Boston, Mass.
Harvard University, Cambridge, Mass.
Columbia University, New York, N. Y.
Lehigh University, So. Bethlehem, Pa.
U. S. Government School of Submarine Defense, Ft. Totten, N. Y.
Armour Institute of Technology, Chicago, Ill.
Pratt Institute, Brooklyn, N. Y.
Lowell Textile School, Lowell, Mass.
Iowa State College, Ames, Iowa.
Antioch College, Yellow Springs, Ohio.
Tri-State College of Engineering, Angola, Ind.
University of Maine, Orona, Me.
University of Utah, Salt Lake City, Utah.
Westinghouse Shop School, Pittsburg, Pa.
Young Men's Christian Association.

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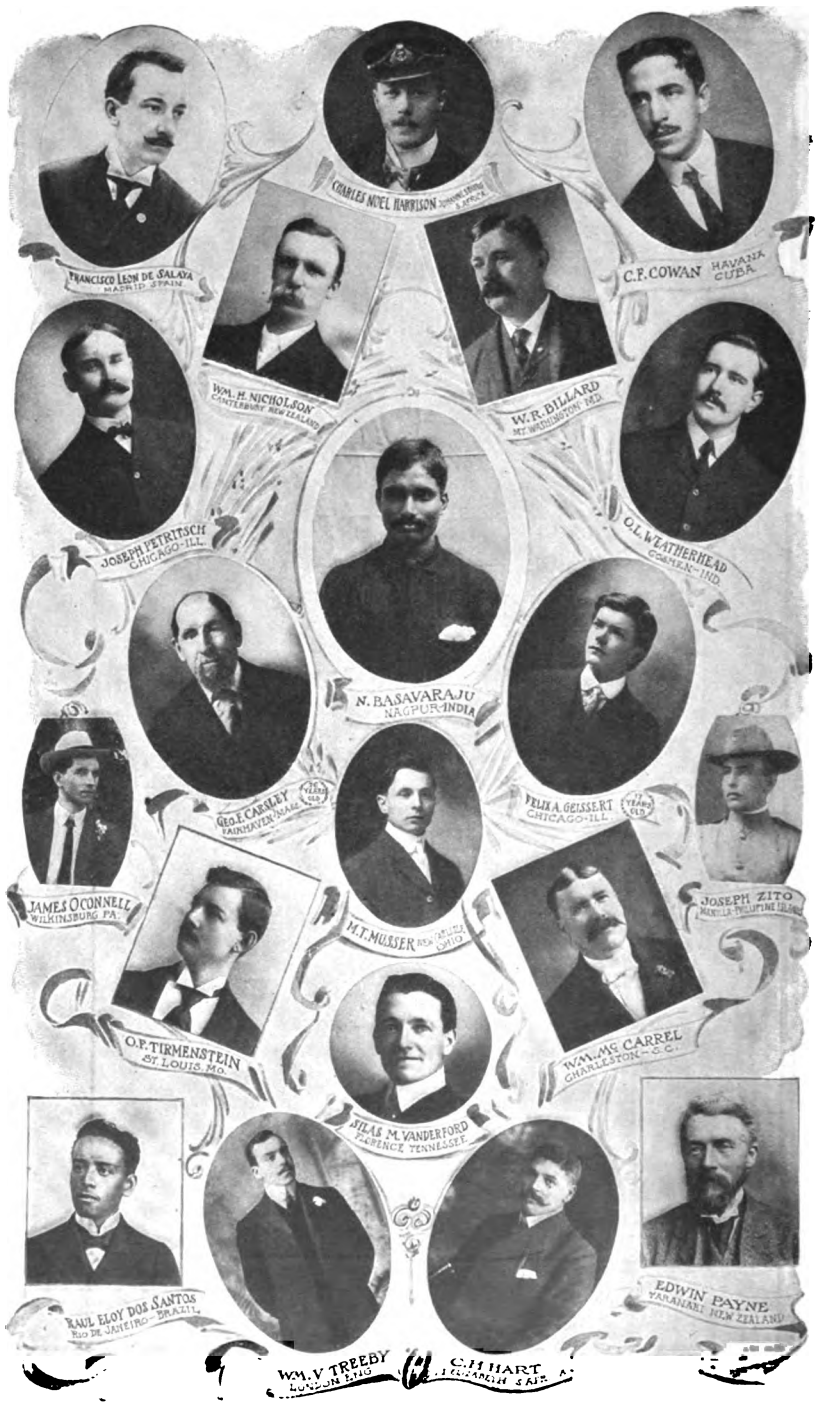

Representative Students and Graduates.

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GRADUATES

In order that the list may be made as accurate as possible, graduates are requested to notify the School of errors or change of address.

Abbe, Geo. C., Warehouse Point, Conn.
Adams, Frank, North Adams, Mass.
Adams, G. C., Winthrop, Me.
Adams, G. W., Winchester, N. H.
Adams, Napoleon A., N. Adams, Mass.
Adamson, G. W., W. Oakland, Cal.
Adamson, W. G., Eldorado, Wis.
Adler, Alphonse A., Brooklyn, N. Y.
Adsit, W. H., Batavia, N. Y.
Affleck, David S., Chesterton, Ind.
Ahrens, John F., Bakersfield, Cal.
Alden, R. C., Marlboro, Mass.
Alden, S. D., Watertown, Mass.
Aldrich, E. F., Beaver City, Nebr.
Aldrich, E. W., Maplewood, Mass.
Alexander, Dan'l, Greenville, Mich.
Alexander, Walter N., Rochester, Minn.
Alford, Smith, Ellwood City, Pa.
Alger, C. R., Lestershire, N. Y.
Allckson, A., Winnebago City, Minn.
Allan, Wm. G., Manchester, England.
Allen, D. A., Ellsworth, O.
Allen, Ralph, Chicago, Ill.
Allen, W. K., Moriah, N. Y.
Altmann, Edw. H., Buffalo, N. Y.
Alvarey, Luis B., New Orleans, La.
Alward, Thos., Indian Head, Md.
Amunds, Fred, Brooklyn, N. Y.
Anderson, C. L., Chicago, Ill.
Anderson, O. N., Melette, S. D.
Anderson, Ulrich, Eau Claire, Wis.
Andin, A. Gust, Stockholm, Sweden.
Andren, C. Frederick, Lynn, Mass.
Andrew, I. A., Medina, Ohio.
Andrews, John, Pontiac, Mich.
Applegate, Raymond, Batavia, Ohio.
Appleton, C. L., Mt. Holly, N. J.
Arbenz, Walter, Hazelton, Pa.
Armstrong, Jas., Plattsburg, N. Y.
Armstrong, M. R., Salem, Ohio.
Armstrong, Ralph, Manhattan, Kans.
Arnold, Geo. B., Warren, R. I.
Arnoldi, Hermann, St. Louis, Mo.
Ashley, Fred S., Florence, Mass.
Ashley, H. S., Fort Worth, Tex.
Ashton, Robert E., Bullion, Pa.
Asquith, Albert, Northboro, Mass.
Athey, D. E., Des Moines, Ia.
Auld, John D., Baltimore, Md.
Aurelius, Thos., Joliet, Ill.
Avila, Miguel, Vera Cruz, Mex.
Axelson, Oscar, Valley City, N. D.
Ayers, E. Ray, Milwaukee, Wis.
Ayson, Ernest E., Otago, N. Z.
Bachelder, Maynard C., Warren, N. H.
Backus, Harry F., Cleveland, O.
Bacon, Frank A., Emporia, Kansas.
Bacon, L. G., Stratford, N. Z.
Badger, Le Roy H., Niles, Mich.
Badger, L. W., Des Moines, Ia.
Bailey, Clarence C., Newton, Kans.
Baker, C. A., Harvey, Ill.
Baker, Fred E., Hastings, Mich.
Baker, Geo. Francis, Buddle, Va.
Baker, H. B., Waynesboro, Pa.
Balcanqual, John, Buffalo, N. Y.
Ball, Edwin, Jr., Ft. Wayne, Ind.
Ballou, Edward A., Pasadena, Cal.
Ballou, E. H., Binghamton, N. Y.
Banks, A. L., Los Angeles, Cal.
Bannan, L., Weatherly, Pa.
Bannister, John A., Chicago, Ill.

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GRADUATES—Continued

Barber, E. M., Everett, Mass.
Barber, Frank W., Erie, Pa.
Barker, Lewis R., Parkville, Mo.
Barlow, F. C., Eau Claire, Wis.
Barnum, Stanley H., Bailey, Mich.
Barr, Arpie, De Witt, Ia.
Bascom, G. R., Boston, Mass.
Bashore, Jesse, Logansport, Ind.
Batchelder, L. J., Laconia, N. H.
Bates, A. H., Elgin, Ill.
Bates, Douglass B., Pittsford Mills, Vt.
Bates, G. W., Nanticoke, Pa.
Baugh, Robt. Spence, Los Angeles, Cal.
Baxter, Leroy F., Blair, Neb.
Beal, Clifford G., E. Bridgewater, Mass.
Beard, Norton S., Holton, Kans.
Beardsley, W. A., Glenwood, Minn.
Beck, Ellis L., Pittsburgh, Pa.
Becker, A. M., Atlanta, N. Y.
Beerbower, Clyde, Salem, Va.
Bell, Lawrence J., Plano, Ill.
Bellows, Frank A., Baldwinsville, N. Y.
Benbow, Burnie L., La Fayette, Ind.
Bennett, Wm. I., Pittsburg, Pa.
Benson, O. R., Chicago, Ill.
Bentall, Frank Wm., Earls Colne, Eng.
Bergborn, C. E., Ft. Hamilton, N. Y.
Bergner, W. G., Peoria, Ills.
Berkheimer, Chas., Ashland, Neb.
Bernhardt, Fred'k P., Chicago, Ills.
Bester, Fred E., Enfield, Mass.
Blathrow, E. D., W. Lebanon, N. H.
Bickford, Oramel S., Greenfield, Mass.
Biddle, J. E. W., Auckland, N. Z.
Bidle, B. A., Wooster, O.
Biggar, D., Edgerton, Wis.
Billard, W. R., Mt. Washington, Md.
Bimmerle, Augustus E., Eden Vale, Cal.
Bindrich, Chas. F., Milwaukee, Wis.
Bivins, Frank H., Port Byron, N. Y.
Black, A. T., West Union, O.
Black, Wm., Chicago, Ill.
Blanthorn, John E., Brooklyn, N. Y.
Blazier, D. D., Ellsworth, Kans.
Blewett, W. G., Edmonton, Alberta, Can.
Blizzard, W. E., Chicago, Ill.
Bolce, C. L., Evanston, Ills.
Bolton, Wm., G., Mixerville, Ind.
Bonnett, J. C., New Haven, Conn.
Boostrom, A. J., Galva, Ill.
Bootsgezel, Jacob J., Groningen, Netherlands.
Bossingham, John E., Manfield, Ohio.
Bothwell, J. L., Mexico City, Mex.
Boughton, S. W., Alma Heights, Mich.
Bourgeois, Philip, Joliet, Ill.
Bower, Jordan W., Manistique, Mich.
Bowman, Chester A., Middleville, Mich.
Bowman, Henry R., Freeland, Md.
Bowring, Geo. P. B., Lowell, Mass.
Boyd, Harry W., Philadelphia, Pa.
Bradley, John J., Amoskeag, N. H.
Breen, Jos. W., Philadelphia, Pa.
Breest, Francis, Arbor Vitae, Wis.
Bretschneider, Edwin C., Amana, Iowa.
Brewer, Chas. A., Noroton Heights, Conn.
Briggs, Howard N., Salem, Mass.
Bright, Geo. W., Chicago, Ill.
Brissel, C. F., Undercliff, N. J.
Bristol, J. S., Danville, Ill.
Bristol, M. L., W. Hartford, Conn.
Brooks, G. W., Mullan, Ida.
Broughton, Wm., Waterbury, Conn.
Brown, Archie C., Avon, N. Y.
Brown, A. R., San Bernardino, Cal.
Brown, Geo. V. A., San Francisco, Cal.
Brown, Robert, Glasgow, Scotland.
Brown, R. D., Ithaca, N. Y.
Brown, R. E., Ft. William, Ont., Can.
Bruischaart, C., Walworth, N. Y.
Brunner, Earle, Spokane, Wash.
Bryant, Sydney V., London, Ont.
Buchan, James, Stanley, N. Y.
Buchs, William L., Buffalo, N. Y.
Buck, C. M., Topeka, Kans.
Buckalew, Wm. F., Philadelphia, Pa.
Buckley, Oliver E., Sloan, Iowa.
Buell, J. A., Wilmington, Vt.
Bull, Hilario Blanch, Madrid, Spain.
Burdeno, Fred J., Grosse Ile, Mich.
Burdick, Chas. A., Coldwater, Mich.
Burford, Frank W., Timaru, N. Z.
Burgess, H. C., St. Louis, Mo.
Burgess, H. E., Chicago, Ill.
Burns, Chas. E., Beverly, Mass.

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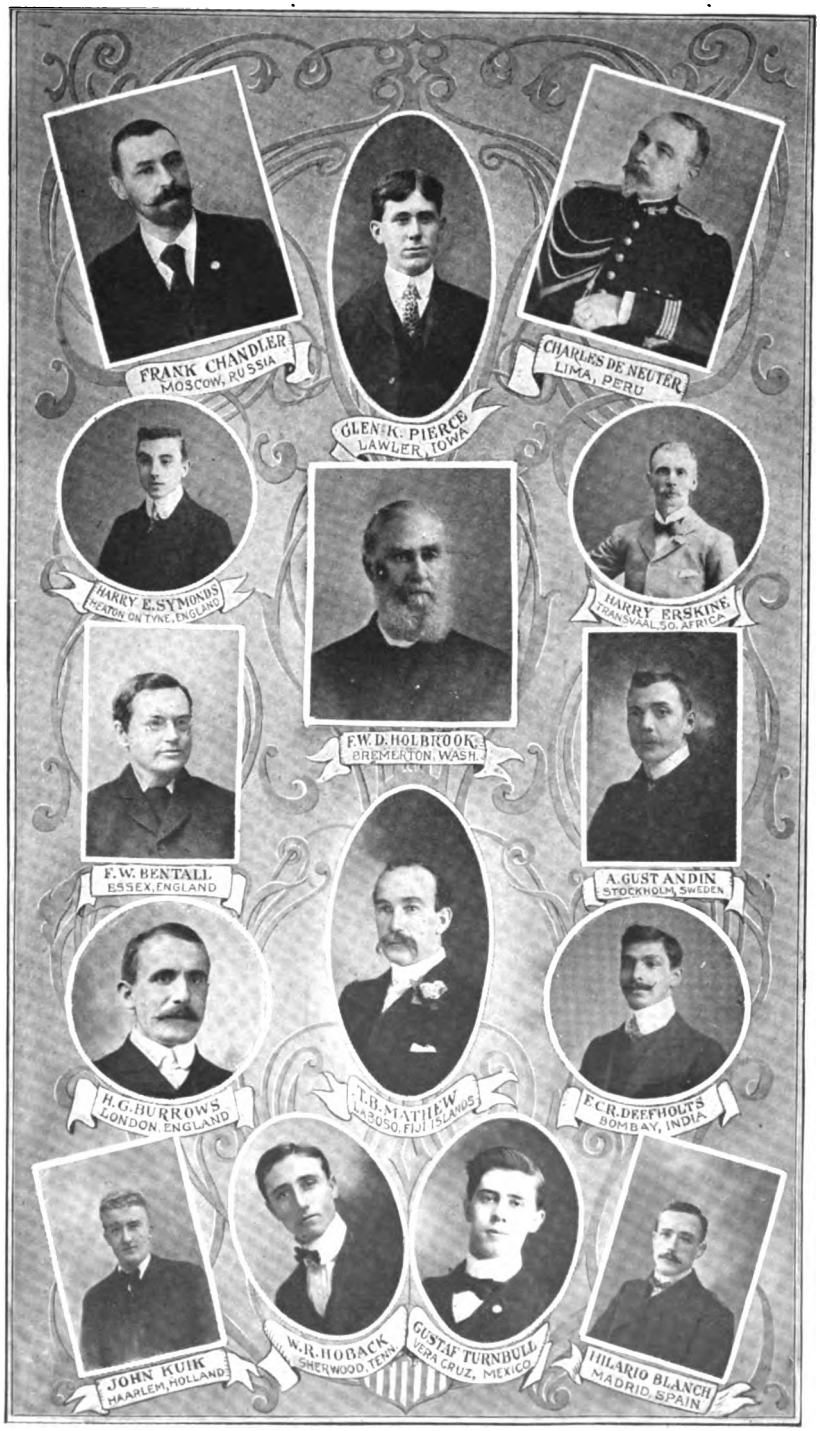

Representative Graduates of the School

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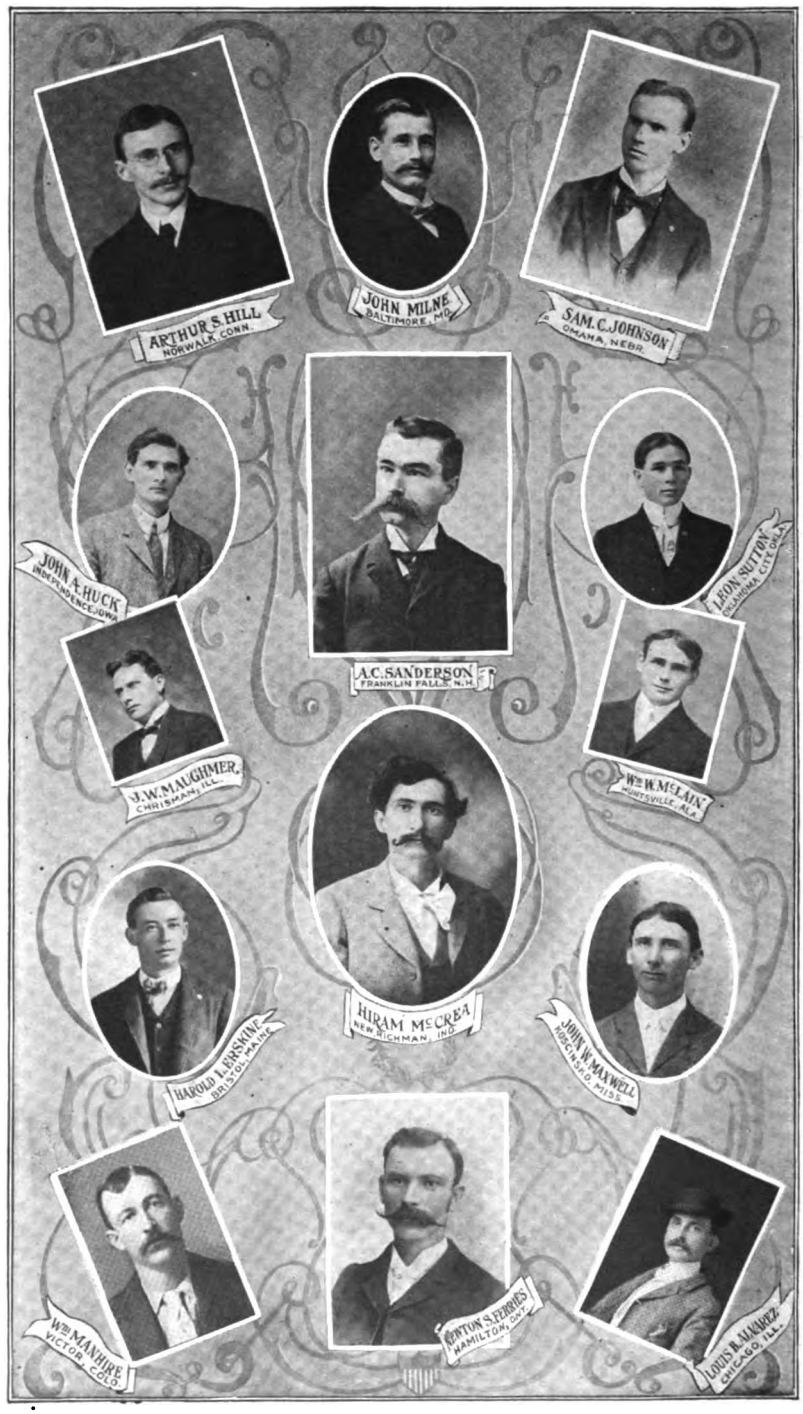

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GRADUATES—Continued

Burns, J., Westland, N. Z.
Burpee, F. D., Ottawa, Ont., Can.
Burr, Ordwell Perry, Leon, Ohio.
Burrows, C. E., Tulare, Cal.
Burrows, H. G., London, England.
Burton, A. R., Green Bay, Wis.
Busch, E., Milwaukee, Wis.
Butler, W. T., Breckenridge, Colo.
Butt, Ernest, Hawkes Bay, N. Z.
Buttgenbach, W. J., Bacon, Philippine I.
Byrne, Ricardo A., Mantanzas, Cuba.
Calhoun, Pearl Randolph, Pittsburgh, Pa.
Calkins, Alvin C., Alpena, Mich.
Callaghan, Martin, Chicago, Ill.
Camacho, Alex. A., St. Johns, B. W. I.
Camacho, Frank E., New York, N. Y.
Campbell, Chas., Campbellstown, Ohio.
Campbell, John K., Los Angeles, Cal.
Cannon, L. J., Hyannis, Mass.
Carlin, Clarence, Loraine, Ills.
Carlock, Fred M., Chicago, Ill.
Carlsen, N. A., Butte, Mont.
Carr, John B., Fall River, Mass.
Carroll, Geo. B., Fairport, N. Y.
Carroll, H. T., Swanton, Ohio.
Carrothers, Lewis E., Adelaide, Ontario.
Carsley, Geo. F., Boston, Mass.
Carstensen, Wm., Walnut, Iowa.
Carter, Fred'k W., New Bedford, Mass.
Caskey, E. M., Trenton, N. J.
Caukin, Ray O., Jackson, Cal.
Chambers, Guy A., Chicago, Ill.
Chambers, Michael A., Warrington, Fla.
Chandler, Frank, Moscow, Russia.
Chandler, G. B., Rose, Kansas.
Chapin, C. C., Sloan, Iowa.
Chaplin, Allen, Geuda Springs, Kans.
Chapman, C. D., Chicago, Ill.
Chapman, C. O., Cincinnati, Ohio.
Chapman, S. J., Wabash, Ind.
Chapman, W. W., Zortman, Mont.
Chase, J. E., Rollin, Mich.
Cheney, F. L., Worcester, Mass.
Cherry, John, Kansas City, Mo.
Chorpening, G. B., Clarksburg, W. Va.
Christesen, Chas., New York, N. Y.
Christie, John, Sidney Mines, N. S.
Christie, John, Jr., Paisley, Scotland.
Church, F. F., Medford, Mass.
Church, Henry I., Caldwell, Kans.
Churchill, Harry E., Beloit, Wis.
Claflin, Arthur, Charleston, Wash.
Clark, Clarence E., Albany, N. Y.
Clark, Harry Lee, Canton, Pa.
Clark, Leroy W., Providence, R. I.
Clark, M. D., Chicago, Ill.
Clark, Ralph C., Poy Sippi, Wis.
Clark, Samuel E., W. Milan, N. H.
Clark, Wm. L., Brooklyn, N. Y.
Clarke, Edw., Paris, Ont., Can.
Clarke, Frank J., Pawtucket, R. I.
Clarke, Reuben R., San Francisco, Cal.
Cleghorn, Leslie F., Port Chalmers, N. Z.
Clemenson, J. R., Milwaukee, Wis.
Clerc, Adrian, Chicago, Ill.
Clifford, James A., Billings, Mont.
Clifton, Clifford R., Ida Grove, Ia.
Cline, H. Dale, Bloomington, Ill.
Clinehens, E. W., Maplewood, Ohio.
Clough, John S., No. Haverhill, N. H.
Cochrane, J. J., New Martinsville, W. Va.
Cole, Chas. R., E. Brownfield, Me.
Colebank, F. M., Madella, Minn.
Coleman, Chas. J., New Berlin, Ohio.
Coleman, Vincent B., Port Hope, Ont.
Coleman, W. E., Hackettstown, N. J.
Colquette, Sherman D., Feversham, Ont.
Comer, George W., Jordan, Wyo.
Compton, Wm. V., Weston, Ohio.
Condon, Patrick J., New York, N. Y.
Conibear, John C., Windsor, Ont.
Conover, Judson L., W. Freehold, N. J.
Cook, Harry L., Malden, Mass.
Cooling, Louis, Wilton Jct., Iowa.
Cooper, Harry W., St. Louis, Mo.
Cooper, Oscar J., Chicago, Ill.
Copeland, Fred E., Thomaston, Me.
Copp, Ralph, St. Louis, Mo.
Corwin, Cecil, Hayward, Cal.
Cost, Irving T., Clifton Springs, N. Y.
Coubrough, Leslie, Tacoma, Wash.
Couture, Archill, Biddeford, Me.
Cover, H. S., South Bend, Ind.
Covington, R. R., Laurinburg, N. C.
Cowan, C. E., Greensburg, Pa.
Cowan, Jno. H., Eagleville, Ohio.

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GRADUATES—Continued

Cox, Wm. H., Rome, N. Y.
Crafts, C. P., Tuscola, Ill.
Cramer, Alonzo A., Amsterdam, N. Y.
Cramer, Sidney R., Belpre, O.
Crapnell, Clay, Chicago, Ill.
Crawford, Frank E., Roxbury, Mass.
Creveling, Chas. S., Bloomsbury N. J.
Cronic, J., Philadelphia, Pa.
Cronin, Frederick W., Worcester, Mass.
Crouch, W. L., Bristol, Conn.
Culbertson, Allen H., Oil Center, Cal.
Culham, Ansley, Stayner, Ont., Can.
Culler, R. Eugene, Lucas, Ohio.
Curl, Lester LeRoy, Lebanon, Ore.
Curow, J. W., Chicago, Ills.
Curry, Harry F., Los Angeles, Cal.
Curtis, Harry S., Chicago, Ill.
Dalton, F. W., Walsingham Center, Ont.
Danhoff, L., Chicago, Ill.
Danner, John, Harvey, Ill.
Darby, W. G., Madison, Wis.
Davenport, Harry C., Blissfield, Mich.
Davenport, H. E., Belma, Wash.
Davey, John, Oshkosh, Wis.
Davidson, Harry L., Canton, Ohio.
Davidson, J. C., Prince Bay, N. Y.
Davis, Arthur A., Clark's Green, Pa.
Davis, A. R., Bloomington, Ill.
Davis, Bainbridge J., Long Branch, N. J.
Davis, Clarence A., Penacook, N. H.
Davis, Chas. E., Chicago, Ill.
Davis, Chas. P., Elmira, N. Y.
Davis, Fred H., Silver Creek, N. Y.
Davis, Hoyt C., Davis, W. Va.
Davis, J. Alder, Amherst, N. S.
Davis, Louis R., Chicago, Ill.
Davis, Luther J., Chicago, Ill.
Davis, Walter S., Little Falls, N. Y.
Davison, C. H., Lyme, Conn.
Day, Allen J., Sanford, Fla.
Day, Lewis E., New Haven, Conn.
Dayton, R. N., So. Norwalk, Conn.
Dean, Elmer, New Brunswick, N. J.
Deefholts, Ernest C. R., Willesden, Eng.
De Groat, George, Plainfield, N. J.
Dehlin, Adolph, Chicago, Ill.
De Lapp, Austin, La Harpe, Ill.
De Mandeville, E. E., New York, N. Y.
De Neuter, Chas., Lima, Peru.
Dero, Louis, Le Havre, France.
Devan, Vincent M., Boston, Mass.
De Vout, Anson, Harrisburg, Pa.
De Witt, Timothy, Westerville, Ohio.
DeWolf, Philip, Salt Lake City, Utah.
Dickerson, Chas. W., Milwaukee, Wis.
Dickerson, Clifton, Echo, Minn.
Dickerson, Ernest B., Renner, Texas.
Dickey, Ernest, Bloomingburg, Ohio.
Dickinson, G. E., Titusville, Pa.
Dickson, J. H., Polk, Pa.
Dickson, W. R., Jamaica Plain, Mass.
Dietzsch, Wm., Alameda, Cal.
Dinsdale, Wm., No. Tarrytown, N. Y.
Dixon, Wm. E., Northboro, Mass.
Dodds, Fred C., Wheaton, Minn.
Dohren, Harry, Jackson, Tenn.
Dollinger, J. G., San Francisco, Cal.
Donlon, Thos., Minnedosa, Man.
Dorman, G. L., Lexington, Mich.
Doughty, Geo. E., Thomaston, Conn.
Dow, Herbert G., Claremont, N. H.
Dowling, Harold L., St. Louis, Mo.
Downey, James A., Dorchester, Mass.
Drake, Arden N., Mapleton, Minn.
Draper, Robert M., Great Falls, Mont.
Drew, Ernest L., Ashmont, Mass.
Drouot, Jos., Warsaw, Ill.
Dubinski, Ben. P., San Antoine, Texas.
Duff, Sidney, Seattle, Wash.
Duguid, John, Hazel Hill, N. S.
Dull, J. Clarence, Hooversville, Pa.
Dunbar, Ernest A., Orange, Mass.
Duncan, Fields M., Liberty, Mo.
Duncan, H. H., Waterloo, Iowa.
Dunham, J. L., Maquon, Ill.
Dunn, J. Howard, Vanderbilt, Pa.
Dunn, L. F., Durango, Colo.
Durant, Clark T., Gt. Barrington, Mass.
Dutenhaver, Raphael, Bippus, Ind.
Each, Henry E., So. Chicago, Ill.
Eames, Henry H., W. Somerville, Mass.
Eaton, A. E., Pinckneyville, Ill.
Eaton, Herbert L., No. Billerica, Mass.
Eaton, Jas., Burlington, Vt.
Eaton, O. S., Island Pond, Vt.
Ebert, Ralph, Burlington, Iowa.

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GRADUATES—Continued

Eckliff, Chas. C., Detroit, Mich.
Eddy, James W., Fall River, Mass.
Eddowes, Ralph K., Riverton, N. J.
Edgar, Louis Clarke, Niles, Ohio.
Edgecomb, Henry R., Edgewood Pk., Pa.
Edward, C. Louis, E. Hampton, N. Y.
Edwards, Frank, Sugar Sta., Utah.
Edwards, Jas. P., Augusta, Ga.
Eichberg, John L., Memphis, Tenn.
Eiler, Walter D., Lebanon, Pa.
Eiselstein, Geo. L., Allegheny, Pa.
Elder, Paul M., Coeur D'Alene, Idaho.
Elftman, John D., Waterloo. Ia.
Elliott, M. C., Cincinnati, Ohio.
Ellis, J. R., South Dunedin, N. Z.
Ellis, Leander S., Andover, Mass.
Ellison, Alfred, Quincy, Mass.
Ellsworth, Chas. T., Forest City, Iowa.
Elmer, Ralph H., Pittsfield, Mass.
Elmquist, Eph., Lindsborg, Kans.
Emrud, Theodore, Alden, Minn.
Enright, M. F., Lemuka, N. Z.
Ermling, E. H., Delaqua, Colo.
Ernst, Carl F., San Francisco, Cal.
Erskine, Harold L., Bristol, Me.
Erskine, Harry, Johannesburg, S. Africa.
Evans, Chas. H., Erie, Pa.
Evans, L. Howard, Strawberry Pt., Ia.
Fabian, Norman J., St. Paul, Minn.
Faris, Maggie H., Allegheny, Pa.
Farnham, Elmer E., Sharon, Mass.
Farnham, H. E., Arlington, Vt.
Farnham, John A. P., Raleigh, N. C.
Faust, E. B., Augusta, Ga.
Fein, Fred W., Newton, Kansas.
Feldhus, H. G., Jr., Hallam, Neb.
Fell, W. C., Imperial, Cal.
Ferguson, Carl L., Parker City, Ind.
Fernstrom, H. O., Chicago, Ill.
Ferries, Newton S., Hamilton, Ont.
Ferris, Wm. Canby, Memphis, Tenn.
Ferry, D. S., Marshville, W. Va.
Fessenden, C. R., Hamilton, Ont.
Field, Frank A., Montreal, Quebec.
Field, W. A., Anoka, Minn.
Fink, Herman J., Minneapolis, Minn.
Finlayson, Peter S., Chatham Islands, N. Z.
Finnerty, Elizabeth, Hulakama, N. Z.
Fishbough, H. E., Springfield, Ohio.
Fisher, J. S., Danbury, Conn.
Fitch, John W., Racine, Wis.
Fittz, F. H., Waltham, Mass.
Fitzpatrick, John E., Buffalo, N. Y.
Fleagle, Jas. E., Mayberry, Md.
Floering, Karl F. H., Ft. Wayne, Ind.
Fogg, Jos., Housatonic, Mass.
Foote, Nelson S., Haverhill, Mass.
Forbes, Homer C., Colebrook, N. H.
Ford, Bert, Chatham, N. Y.
Ford, Thomas C., San Leandro, Cal..
Forrest, James M., Arlington, N. J.
Forrest, L. A., Bakersfield, Cal.
Forschner, C. W., Cleveland, O.
Fox, Warren T., Baltimore, Md.
Foye, Herbert W., Revere, Mass.
Frane, L. W., Spencer, Wis.
Frease, George E., Youngstown, O.
Freeberg, C. P., Chicago, Ill.
Frederickson, Geo. H., Chicago, Ill.
Freer, Edward W., Chisholm, Minn.
French, C. A., Fall River, Mass.
French, E. C., Rochester, N. Y.
Friedman, E. M., Bronson, Mich.
Fritz, Will, Tupperville, Ont.
From, E. C. C. K., Copenhagen, Denmark.
Fuchs, Ernesto, Guadalajara, Mex.
Fuller, Arthur C., New London, Conn.
Fuller, Frank I., Swampscott, Mass.
Fuller, J. C., Peoria, Ill.
Fuller, Raymond C., Quarryville, N. J.
Fullmer, Geo. M., Saugerties, N. Y.
Fulton, Fred, Iola, Kansas.
Fulton, H. H., Jamaica Plain, Mass.
Gabbert, H. W., Owensboro, Ky.
Gabel, Emily A., Chicago, Ill.
Gallop, Carl A., E. Liverpool, Ohio.
Gamble, W. L., Plainfield N. J.
Gamenthaler, G. A., Barnesville, O.
Gardiner, H. B., Chicago, Ill.
Gardner, Clyde P., Liverpool, N. S.
Garfield, Perley E., So. Shaftsbury, Vt.
Garrison, Joel C., Austin, Texas.
Gaskill, John T., Frankford, Pa.
Gates, Walter L., Bellows Falls, Vt.

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Gauvin, Abbott J., Morrisville, Vt.
Gee, W. Howard, Rockport, Mass.
Geizer, Louis, Dufferin Mines, N. S.
George, E. M., Gaffney, S. C.
Gery, Clifford R., Greenfield, Ind.
Getchell, Fuller J., Boston, Mass.
Gibbs, Jno., Lamar, Colo.
Gibler, Harry, Buford, Colo.
Gilbert, Fred A., Minneapolis, Minn.
Gilbert, Moses, Pomona, Mich.
Gillespie, Guy, Oxford, Ind.
Gillespie, H. Clay, Russell, Ky.
Gilmore, Manley M., Chesterland, O.
Glasberg, Jos. J., Cleveland, Ohio.
Glidden, Irving H., Brockton, Mass.
Glosser, John F., Mansfield, Ohio.
Goessy, A. L., Kansas City, Mo.
Goforth, James G., Du Quoin, Ill.
Goforth, W. A., Du Quoin, Ill.
Goggans, Daniel F., Pittsfield, Mass.
Goldner, T. A., Leadville, Colo.
Goltra, Edward B., Chicago, Ill.
Gonstead, J. A., Minneapolis, Minn.
Goodale, Samuel P., Saco, Me.
Goodmann, Ernest A., Champaign, Ill.
Gore, Chas. W., La Grande, Ore.
Gould, Clifford, Chicago, Ill.
Gould, Wm. A., Chicago, Ill.
Gowell, Robt. N., Fitchburg, Mass.
Graham, D. A. J., Brooklyn, N. Y.
Graham, W. B., Crestline, O.
Granger, M. B., Brooklyn, N. Y.
Graves, Kinzie A., Mexico, N. Y.
Gray, L. A., Burke, Idaho.
Green, A. M., Jersey City, N. J.
Green, Jay P., Mound City, Mo.
Green, R. F., Walkerville, Ont.
Greetham, Francis, Chicago, Ill.
Greunewald, Harry, St. Louis, Mo.
Griesmer, E. E., King's Mills, Ohio.
Griffith, William R., Utica, N. Y.
Grip, Edward, Los Angeles, Cal.
Grover, Sidney F., Newburyport, Mass.
Gudgel, C. H., Deputy, Ind.
Gue, Irvin, Guilford, Mo.
*Guilford, William M., Portland, Me.
Guss, W. A., Delphos, Ohio.
Gutgesell, Julius, St. Louis, Mo.
Guthrie, Lawrence R., New Orleans, La.
Guthrie, Walter B., Bloomfield, Iowa.
Haas, Ed., Dixon, Ill.
Haas, Jno. H., Jr., Amana, Iowa.
Hadley, Ralph, Hagerstown, Ind.
Haefner, Wm., Elmira, N. Y.
Hagemann, L. C., St. Louis, Mo.
Haines, Henry Sherwin, Decoto, Cal.
Hale, Frank J., Scranton, Pa.
Hale, Geo. W., Chicago, Ill.
Hall, George G., Boston, Mass.
Hall, Jno. L., Downer's Grove, Ill.
Hall, Ward, La Moille, Ill.
Hall, Wilbur P., Llanerch, Pa.
Hallgren, John, Chester, Pa.
Hamilton, William F., Joliet, Ill.
Hammond, A. N., Erie, Pa.
Hammond, Rupert, Chicago, Ill.
Hanan, Ed., Mt. Sterling, Iowa.
Hannan, Thomas F., Schenectady, N. Y.
Hans, Frederick W., Chicago, Ill.
Hanson, I. M., North Billerica, Mass.
Harbaugh, Verde L., Southwest, Pa.
Hardy, M. R., Portland, Me.
Harrington, D. H., Boston, Mass.
Harris, S. W., Royal Centre, Ind.
Harrison, C. E., Newport, R. I.
Harrison, W. E., Chicago, Ill.
Hartwig, William, Jr., West Point, Neb.
Hatherell, A. N., Appleton, Wis.
Hatton, Herbert C., N. Stroud, England.
Hauser, Geo., Milwaukee, Wis.
Hawk, E. Z., Mongo, Ind.
Hayes, J. P., Pittsburg, Pa.
Hayne, Joseph, Andalusia, Ala.
Hazlehurst, Robt., Michigan City, Ind.
Heinrichsmeyer, M., St. Louis, Mo.
Helgeson, H., Butte, Mont.
Helmchen, Wm. P., Chicago, Ill.
Henderson, Carl H., Ft. Valley, Ga.
Henderson, Jas. H., Hyde Park, Mass.
Henderson, L. A., Vincennes, Ind.
Hendrick, F. C., Chicago, Ill.
Hendricks, W. W., Bardolph, Ill.
Henschke, J. C., York, Pa.
Hepke, Geo., Hamilton, Ohio.

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Herald, Charles A., Hamilton, Ont.
Herrick, H. G., New Haven, Conn.
Herring, George W., Wolcott, Vt.
Herrling, Otto, Stayton, Ore.
Herron, Thos. M. R., Ft. Banks, Mass.
Hetzler, G. E., Dayton, O.
Hewitt, T. H., Poquonoc Bridge, Conn.
Heyrodt, Herman, Bridgeport, Conn.
Hickin, William D., Central Lake, Mich.
Higbee, G. M., La Crosse, Wis.
Higgins, A. E., San Diego, Cal.
Higgins, George E., St. Henry, Quebec.
Higgins, Wallace E., Chelsea, Mass.
Hiler, Frank E., Joliet, Ill.
Hill, Arthur S., Norwalk, Ct.
Hill, Eugene H., Milwaukee, Wis.
Hill, Howard J., Winnebago City, Minn.
Hill, R. B., Yorkshire, England.
Hilser, Wm., Newark, N. J.
Hilsinger, Frank A., Orange, N. J.
Hilton, Frederick, Fall River, Mass.
Himburg, John A., Troy, Ala.
Hinkel, Jacob, Reading, Pa.
Hird, Arthur, Lowell, Mass.
Hjerleid, Carl M., Moorhead, Minn.
Hoback, W. R., Sherwood, Tenn.
Hobart, Louis C., Waterbury, Conn.
Hobbs, Anson B., Dorchester, Mass.
Hodgson, E. W., Taranaki, N. Z.
Hoffelt, Anthony, Cape Colony, S. Africa.
Hogg, G. A., Wanganui, N. Z.
Hokanson, Gustav, Three Rivers, Mich.
Hoke, I. A., Shippensburg, Pa.
Holbrook, F. W. D., Bremerton, Wash.
Hollywood, Clifford S., Webb City, Mo.
Hollywood, Jno., Auckland, N. Z.
Holmes, Frank, Oil City, Pa.
Holmes, M. L., Benton Harbor, Mich.
Holsworth, Frank, New York, N. Y.
Hooper, Frederic E., N. Andover, Mass.
Hoover, Thornton, Genoa, Ill.
Hopkins, E. F., Chicago, Ill.
Houghton, Stanley W., Springfield, Mass.
Hoult, James E., Patterson, N. J.
Hovey, Paul, Schenectady, N. Y.
Howard, C., Corozal, British Honduras.
Howard, Nelson L., Lowell, Ind.
Howell, John F., Emporia, Kansas.
Howell, W. H., Gaylord, Kansas.
Howland, Cary E., Bloomingburg, O.
Hubbard, Frank O., Chicago, Ill.
Hubbard, Harvey H., Ironwood, Mich.
Huck, John, Independence, La.
Hudelson, Carl S., Poplar Bluff, Mo.
Hudson, Ross N., Sanborn, N. Y.
Hudson, T. P., Houston, Texas.
Huffman, Oliver L., Linden, Iowa.
Hughes, B. A., Colorado Springs, Colo.
Hughes, C. S., Washington, D. C.
Hughes, David, San Francisco, Cal.
Hulbert, John W., Jr., Auburn, N. Y.
Hull, Walter H., Torrington, Conn.
Humble, W. H., Victoria, Australia.
Humphrey, R. P., Adrian, Mich.
Hunsicker, Clyde, Binghamton, Cal.
Hunt, J. H., N. Tonawanda, N. Y.
Huse, Ernest L., Beverly, Mass.
Hutchinson, Leon A., Milford, N. H.
Hutchinson, M. L., Jalapa, Mexico.
Huther, William F., Canton, Ohio.
Hux, Charles L., Owosso, Mich.
Hynds, Homer J., Hyndsville, N. Y.
Imes, Jason, Audubon, Ia.
Ingberg, S. H., Hendrum, Minn.
Inglis, Dr. H. McC., Christchurch, N. Z.
Inman, Fred A., Wallace, Idaho.
Ishii, F. N., San Francisco, Cal.
Ives, F. C., Rutland, Vt.
Jack, J. A., Bieber, Cal.
Jackson, Claude E., Beresford, S. D.
Jackson, H. D., Chicago, Ill.
Jackson, H. E., Chicago, Ill.
Jackson, Kurt, Chicago, Ill.
Jackson, W. H., Pittsboro, Ind.
Jacobson, H. O., Chicago, Ill.
Jaeger, Chas. T., Tacoma, Wash.
Janda, Frank, Chicago, Ill.
Jenkins, W. Harry, Philadelphia, Pa.
Jennings, Charles, Cambridge, Mass.
Jenny, Fred, Juda, Wis.
Jensen, Jas. J., Vallejo, Cal.
Jensen, Julius, Chicago, Ill.
Jessop, Edward, York, Pa.
Job, S. J., Newark, Mo.
Johnson, Bert W., Warren, N. H.
Johnson, Boyd C., Indiana Harbor, Ind.

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Johnson, Chas. E., Dorchester, Nebr.
Johnson, E. L., Warrensburg, O.
Johnson H. Bert, Richmond, Va.
Johnson, John L., Boston, Mass.
Johnson, Sam C., Omaha, Nebr.
Johnson, Walter, Bark River, Mich.
Johnston, Louis K., Chicago, Ill.
Jones, Claude L., Royse City, Texas.
*Jones, Howard C., Malvern, Pa.
Jones, J. M., Ferris, Texas.
Jones, T. J., Keswick, Cal.
Jongebloed, Marius, St. Louis, Mo.
Jordan, S. R., Honolulu, Hawaii.
Jordon, E. B., Nevada, Ia.
Joseph, William B., W. Oakland, Cal.
Joy, R. P., Chapin, Ill.
Judd, Frank R., Chicago, Ill.
Julian, Victor H., Ridgefarm, Ill.
Jung, Oscar, Milwaukee, Wis.
Jupenlaz, Aug. G., Fort Ethan Allen, Vt.
Jurs, Henry C., No. Collins, N. Y.
Kaiser, Louis, Columbus, Ohio.
Kammeyer, Harry H., Montford, Mont.
Kane, John W., Derby, Conn.
Karlson, John, Orange, Mass.
Kasley, Wm. G., Wheeling, W. Va.
Katz, John E., Ridgewood, N. J.
Kays, Lucian B., Kellam, Pa.
Kaze, Hugo, Galesburg, Ill.
Keane, P. J., Bellows Falls, Vt.
Kedney, L. S., Vera Cruz, Mexico.
Keiper, Chas. J., Chicago, Ill.
Keil, O. L., Chicago, Ill.
Keithline, Sam'l P., Wilkes Barre, Pa.
Kellar, John G., Albany, N. Y.
Kellersberger, A. C., Cypress Mill, Tex.
Kellogg, C. M., Holyoke, Mass.
Kelly, J. W., Chicago, Ill.
Kenworthy, G. E., Portland, Me.
Kenyon, J. A., Ironwood, Mich.
Keppel, Thomas, Zeeland, Mich.
Kerr, E. B., Laconia, N. H.
Kerr, Mathew H., Toronto, Ont.
Kettmann, Harry, Kidd, Ill.
Killam, W. S., Yarmouth, Nova Scotia.
Klitz, Clyde E., Chicago, Ill.
Kimball, Ray C., Milbank, S. D.
Kime, Ralph V., Kendallville, Ind.
King, S., Agricultural College, Mich.
King, W. B., St. Catherines, Ont.
Kirk, G. E., Milwaukee, Wis.
Kirk, W. B., W. Peterboro, N. H.
Kistler, Otto, Royal Centre, Ind.
Klein, Floyd A., Chicago, Ill.
Klepper, O. R., Chicago, Ill.
Klinger, Jno. S., Fearnot, Pa.
Klotz, Andrew J., Schenectady, N. Y.
Kleyensteuber, F. F., Chicago, Ill.
Knapp, Leo. J., Weston, Mich.
Knopf, Mathias, Paterson, N. J.
Knopp, E. G., Columbus, Ohio.
Knowles, Edwin G., Lowell, Mass.
Knowles, William H., Hartford, Conn.
Knowlton, Frank Le Roy, Dover, N. H.
Knutson, Nels, Waseca, Minn.
Koellner, Henry, Chicago, Ill.
Kouns, James H., Portland, Oregon.
Kozlarek, John, Jr., Stissing, N. Y.
Kraus, Chas. E., Springfield, Ohio.
Krauss, Alvin A., West Point, Pa.
Kreusch, Adalf, Tonawanda, N. Y.
Kreusch, Albert, Tonawanda, N. Y.
Krog, Peter, Beandette, Minn.
Krul, Jacob, W. Everett, Mass.
Kruse, F. A., Tyler, Minn.
Kuenhold, Otto J., Cleveland, O.
Kuik, J., Haarlem, Holland.
Kunze, Arthur F., Washington, D. C.
Kvitrud, Gilbert, Minneapolis, Minn.
Kylberg, Sylvester C., Milburn, N. J.
Lafleur, Paul, Westmount, Quebec.
Lagerwall, T., Augusta, Ga.
Laidley, John W., Mountain Grove, Ont.
Lamb, N. Edw., Taunton, Mass.
Lance, A. Ward, Schenectady, N. Y.
Lane, Harry L., Silver Lake, Mass.
Laner, Frank, St. Henry, Quebec.
Langdon, Gordon, Sabina, Ohio.
Langsdale, B. W., Kansas City, Mo.
Langston, J. G., Chicago, Ill.
Langwick, John, Chicago, Ill.
Larkin, J. E., Aurora, Ill.
de Larrea, G. B. F., Madrid, Spain.
Larsen, Chris, Tacoma, Wash.

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Larson, Fred, Chicago, Ill.
Lawrence, Geo. C., Stony Creek, Conn.
Lawrence, S. B., Ridgway, Pa.
Lee, J. E. S., Thurber, Texas.
Lehman, E. T., Cambridge, Mass.
Lehman, M. A., Prineville, Oregon.
Lehmer, Howard, Shanesville, O.
Lehner, Annie, Mullan, Idaho.
Leighty, Ralph, Vermont, Ill.
Leinenkugel, Henry, Eau Claire, Wis.
Leite, Lysanias de Cerqueira, Rio Janeiro, Brazil.
Leitenstorfer, H., Chicago, Ill.
Lemm, Chas., Chicago, Ill.
Leonard, M. S., Hyde Park, Mass.
Leslie, Norman, Philadelphia, Pa.
Letts, Arthur, Lincoln, Eng.
Lewis, E. A., Butternut, Mich.
Lightbody, Frank, Bath, Me.
Lillie, B. E., Lowell, Mich.
Lincoln, E. S., Brookline, Mass.
Lincoln, Frank P., Milton, Mass.
Lindemann, Max, Trenton, N. J.
Lindholm, John I., Bridgeport, Conn.
Lindsay, George, Dunedin, N. Z.
Lindsay, H. N., San Francisco, Cal.
Lobban, William, Milton, Mass.
Lockhart, Geo. S., Peekskill, N. Y.
Lockney, Ira L., N. Fond du Lac, Wis.
Lockwood, E. L., Minneapolis, Minn.
Loden, Henry S., Edgewater, Md.
Loder, Morris G., Chicago, Ill.
Loetscher, Charles B., Waupeton, Iowa.
Logue, J. F., Graysville, Ohio.
Long, J. I., Acme, Kansas.
Loomis, A. P., Columbus, Wis.
Lowry, Walter L., Camden, S. C.
Loxterman, Harry F., Chicago, Ill.
Lua, J. P., N. Tonawanda, N. Y.
Lundberg, Gust Edward, Chicago, Ill.
Lundquist, W. E., New Harbor, Me.
Lynn, A. Claude, Fairfield, Ohio.
Lyons, Garth T., Clay Center, Neb.
Mable, Don C., Chicago, Ill.
Mackay, Chas. W., Brighton, O.
Macloon, Ernest Henry, Copperfield, Vt.
Mac Vean, D. M., San Francisco, Cal.
Mac Williams, J. Fred, Chicago, Ill.
Magnet, S. S., Lebanon, Ohio.
Maier, J. W., Sharon, Pa.
Maitland, Neil, Windsor, Ont.
Malany, Geo. U., Chester, Pa.
Manhire, Wm., Russell Gulch, Colo.
Manning, C. F., No. Billerica, Mass.
Marchand, Charles H., Drytown, Cal.
Marcus, Max, Chicago, Ill.
Marshall, H. H., Queensland, N. Z.
Martens, Chas., Chicago, Ill.
Martens, H. C., Chicago, Ill.
Martin, Harry, Milford, Utah.
Martin, Herbert, Suamico, Wis.
Martin, James F., Danbury, N. C.
Martin, M., Elkton, Ohio.
Marx, Gustave C., Elizabeth, N. J.
Mason, Lena Belle, E. Bloomfield, N. Y.
Mathews, T. B., Labasa, Fiji Islands.
Maughmer, John W., Newport, Ind.
Maxwell, John W., Jackson, Miss.
Maynard, M. E., Waukesha, Wis.
McAdams, J. J., Caldwell, Ohio.
McBride, Joseph, Chicago, Ill.
McCarrel, William, Charleston, S. C.
McCause, Fenelon T., Kinsley, Kansas.
McClean, C. Ronald, Brooklyn, N. Y.
McClean, F. W., St. Catharines, Ont. Can.
McCrary, Harry R., Concordia, Kansas.
McCrea, Hiram, New Richmond, Ind.
McDiarmid, L. A., Albion, Mich.
McDonald, Donald, Chicago, Ill.
McDonald, Elmer, Milwaukee, Wis.
McDowell, Thomas D., Pocatello, Idaho.
McEwen, S. H., Chicago, Ill.
McGill, A. L., Bullion, Pa.
McGill, Thos., Sydenham, London, S. Eng.
McGlothlin, W. H., Portland, Tenn.
McInnes, Angus C., Port Chalmer, N. Z.
McIntosh, Lewis W., Poughkeepsie, N. Y.
McKee, John S., Pittsburg, Pa.
McKenzie, Norman, Bourbon, Ind.
McKinley, Howard, Camden, N. J.
McLain, Wm. W., Huntsville, Ala.
McLaughlin, D. F., Campo, Cal.
McLean, Charles, Dunning, Ill.
*McLean, Elmer L., Moline, Ill.

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McLeod, John D., Billerica Center, Mass.
McLoud, L. E., Port Byron, N. Y.
McMaster, Harry W., Middleport, Ohio.
McMillan, J. H., Brantford, Ont.
McNab, J. V., Ayr, Ont.
McNidder, T., Shanghai, China.
McQueen, Fred E., Johnstown, Pa.
McQuigg, C. Ellison, Ironton, Ohio.
McQuown, W. E., Toledo, Ohio.
Melvin, Thos., Bowling Green, Mo.
Menocal, A. J., Washington, D. C.
Menut, James Gardner, Lydonville, Vt.
Merz, Robert E., Carlinville, Ill.
Miller, B. Frank, Chicago, Ill.
Miller, George, Berlin, Ont.
Miller, Perry F., Chicago, Ill.
Miller, Sophia, Scottsville, N. Y.
Miller, W., Detroit, Mich.
Miller, W. J., W. Bay City, Mich.
Milne, John, Baltimore, Md.
Mitcham, Robert W., Camden, S. C.
Mitchell, Albon H., Chateaugay, N. Y.
Mitchell, B. M., N. East, Pa.
Mitchell, Floyd K., Inman, Tenn.
Mitchell, Jno. L., Kane, Pa.
Molloy, Charles P., Hubli, India.
Monson, Charles H., Otago, N. Z.
Montgomery, E. G., Topeka, Kansas.
Montgomery, W. C., Alexandria, Ind.
Moore, Albert, Green River, N. Y.
Moore, A. A., Cambridge, Ohio.
Moore, D. Edwin, Chicago, Ill.
Moore, Robert N., Ironton, Ohio.
Morford, A. W., New Monmouth, N. J.
Morgan, James P., Philadelphia, Pa.
Morgan, Martin, Indianapolis, Ind.
Morton, David A., Chicago, Ill.
Moss, Arthur E., Port Chalmers, N. Z.
Moulton, E. C., Portsmouth, Va.
Moyse, Vittorio, Milan, Italy.
Mulock, Wilson M., Surfside, Mass.
Mundorf, A. R., Hanover, Pa.
Murphy, B. E., Joliet, Ill.
Murray, Harold, Forest, Cal.
Musser, M. T., New Carlisle, Ohio.
Muth, Arnold, Holdrege, Neb.
Naylor, George M., Melrose Highlands, Mass.
Neafie, W. Arthur, Elmira, N. Y.
Neff, John A., Butler, Ohio.
Nekervis, James, Calumet, Mich.
Nelson, Chas. E., Chicago, Ill.
Nelson, John, Manistee, Mich.
Nelson, Maxamilian, Pomeroy, Iowa.
Nelson, N. Emil, Traverse City, Mich.
Nelson, Olof A., Logan, Utah.
Nemitz, Fred, Chicago, Ill.
Nequette, Louis, Two Rivers, Wis.
Nessler, Reinhart, E. Cambridge, Mass.
Neubauer, Fred, Lacey, Wash.
New, Matthew, Chicago, Ill.
Nickerson, David M., Rochester, N. Y.
Niles, Wm. A., New Haven, Conn.
Nims, L. W., Sandy, Utah.
Nisley, Ralph, Selden, Ohio.
Niven, Duncan G., Gisborne, N. Z.
Noble, Frank W., Pittsfield, Mass.
Nordeen, H. G., Seattle Wash.
Norton, Floyd, Charlevoix, Mich.
Oberg, G. H., Upland, Sweden.
O'Brien, E. W., Jr., Providence, R. I.
O'Connell, James, Wilkinsburg, Pa.
O'Connor, Walter E., Chicago, Ill.
Ogden, C. H., Elnora, N. Y.
Ogilvie, A. L., San Francisco, Cal.
O'Hagan, Henry P., Aurora, Ill.
O'Harrow, John, Jr., Hudson, Mich.
O'Neal, Ernest B., Albany, Mo.
O'Neil, John, New Orleans, La.
O'Neill, Harry B., Westmount, Quebec.
O'Neill, Wm., Baltimore, Md.
Ormerd, Oscar, San Diego, Cal.
Osborn, Rex Elmer, Toledo, Ohio.
Osborne, Matthew, Wellington, N. Z.
Palmer, Geo. E., Laurel Lake, Pa.
Palmer, Ray A., New Bern, N. C.
Palmerton, M., Sioux City, Ia.
Palmquist, A. F., Knapp, Minn.
Parker, Chauncey, Chicago, Ill.
Parker, Edw. F., Fairfield, Me.
Parker, Geo. H., Proctorsville, Vt.
Parker, Walter G., Auburn, Me.
Parker, Willard A., Boston, Mass.
Parlin, F. A., So. Paris, Me.
Parrott, Louis N., Lebanon, Ill.
Patch, H. M. Stevens Point, Wis.

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Patch, Thos. G. A., Joliet, Ill.
Pattemore, A. T., Sacramento, Cal.
Patterson, Everett, Ardena, N. J.
Patterson, L. A., Rockland, Me.
Pattingill, Ira, St. Louis, Mo.
Patton, C. D., Indianapolis, Ind.
Payne, Edwin, Taranaki, New Zealand.
Payne, J. O., Washington, D. C.
Pazandak, Ferd. A., Fullerton, N. D.
Peacock, Jas. M., Stella, Mo.
Pearcey, J. W., Mazomanie, Wis.
Peberdy, Warner, Rugby, England.
Pedersen, Adolph, Cleveland, Ohio.
Pember, Val. M., Emporia, Kansas.
Pence, Henry, Jr., Eaton, Ohio.
Penny, Rodney C., Bangor, Me.
Periman, Israel, Chicago, Ill.
Perkins, Chas. F., Wilmington, Del.
Perrin, P. D., Ypsilanti, Mich.
Perry, Chas. H., Gardner, Mass.
Peterman, Lewis S., W. Chester, Pa.
Peters, B. A., Melrose Park, Ill.
Peters, Fred, Liberty, Mo.
Peters, F., Jr., Appleton, Minn.
Peters, John M., Philadelphia, Pa.
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Petritsch, Jos., Chicago, Ill.
Petterson, Olof G., Worcester, Mass.
Pierce, Asa F., Willet's Pt., N. Y.
Pierce, A. L., Wallingford, Conn.
Pierce, Chas. W., Tuskegee, Ala.
Pierce, Eugene, Ilion, N. Y.
Pierce, E. B., Alameda, Cal.
Pierce, Glen, Lawler, Ia.
Pittman, R. A., Cuero, Texas.
Plumb, W. C., Parkersburg, W. Va.
Polhemus, P. B., E. Roselle Pk., N. J.
Pollard, Alfred, Bear Lake, Mich.
Pollard, R. M., Denver, Colo.
Pond, Geo. A., Manchester, N. H.
Pontius, J. H., Parsons, W. Va.
Porter, H. D., Clinton, Ont., Can.
Porter, Jno. J., Buena Vista, Va.
Potter, H. H., Madison, Ind.
Potter, W. W. Wabash, Ind.
Poutier, Stephen, Buffalo, N. Y.
Powell, F. W., Amherst, Mass.
Powell, V. Ross, Dayton, Ohio.
Powers, Wm., Montreal, P. Q.
Pratt, E. J., Webb City, Mo.
Pray, Henry, Traverse City, Mich.
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Quinn, Chas. F., Cavendish, Vt.
Quist, Irving E., Lake Elizabeth, Minn.
Ramos, Ricardo, Peru, S. A.
Ramsey, Russell H., Germantown, Pa.
Rand, T. P., Woodsworth, La.
Rattray, Chas. H., Milo, Me.
Rau, Irving T., Prairie du Chien, Wis.
Rawson, Harold, Taranaki, N. Z.
Ream, Frank Jos., Chicago, Ill.
Reaume, Harvey, Trenton, Mich.
Redman, A. E., Huntington, Ind.
Rees, J. Thos., Hokendauqua, Pa.
Reeves, E. C., Chicago, Ill.
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Reynolds, C. E., Janesville, Wis.
Reynolds, Harry, Antigo, Wis.
Reynolds, H. V., Eaton Rapids, Mich.
Reynolds, J. R., Marshall, Texas.
Reynolds, Willis L., Milton Mills, N. H.
Rice, Jacob J., Kingston, N. Y.
Rice, M. H., Stanwood, Ia.
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Richardson, F. M. M., Nashville, Tenn.
Richmond, Oscar, Stroudsburg, Pa.
Richmond, W. E., No. Adams, Mass.
*Rideout, Geo. L., Bangor, Me.
Riesebeck, Ernest, Petoskey, Mich.
Riess, Wm. H., Elkhart Lake, Wis.
Riordan, John M., Allston, Mass.
Risch, J. Z., Delft, Holland.
Riter, N. J., Ironton, Ohio.
Robb, Thomas, Brooklyn, N. Y.
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Roberts, Edw. Clayton, Passaic, N. J.
Roberts, E. F., Dunedin, New Zealand.

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Rogers, Harry C., Manchester, N. H.
Rogers, Thos. V., Muscoda, Wis.
Rogers, Wm. A., Petersburg, Va.
Roland, Chas., Otago, N. Z.
Rolston, Herbert, Montreal, Que., Can.
Romanelli, Emilius, Philadelphia, Pa.
Roney, A. V., Middletown, Ohio.
Rood, Wm. G., Bristol, Conn.
Root, J. Sherman, Chicago, Ill.
Rose, Cassius C., Paducah, Ky.
Rosene, L. H., Chicago, Ill.
Ross, H., New York, N. Y.
Roth, Edward N., Chicago, Ill.
Roush, Leroy C., Chicago, Ill.
Rowan, Arthur, Detroit, Mich.
Rowan, James J., Chicago, Ill.
Ruck, Eugene W., Tampico, Ill.
Ruff, A. C., Ohio, Ill.
Rugan, H. F., New Orleans, La.
Rupel, Albert, Wall, Ind.
Rusk, Thomas, Everett, Ont.
Russell, C. W., Thompson's Island, Mass.
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Sampson, H. J., Auckland, New Zealand.
Sanderson, A. C., Franklin Falls, N. H.
Sargent, James, New Market, N. H.
Sawyers, Alex. G., Westerly, R. I.
Schabinger, Chas. H., Marshall, Mich.
Scheufler, Chas. W., Upper Sandusky, O.
Schimpff, Emil, Peoria, Ill.
Schlaegel, F. B., Chicago, Ill.
Schley, Frank H., Council Bluffs, Iowa.
Schmidt, F. E., Mt. Vernon, N. Y.
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Schwarz, Paul, Bloomington, Ill.
Scidmore, Grover E., Hemlock, N. Y.
Scoates, Daniel, So. Milwauke, Wis.
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Sharp, Reuben W., Lorain, Ohio.
Shaw, Jas. Herbert, Newport, R. I.
Sheadel, James B., Churubusco, Ind.
Shearer, H. M., Chapelle, S. D.
Shedd, Milton C., El Paso, Texas.
Sheets, Wm. M., Lowell, Ind.
Sheldon, Frank C., N. Jackson, Pa.
Sheldon, Wilber E., Rolla, Mo.
Sherwood, Llewellyn L., Leipsic, Del.
Sherwood, W. W., Green Springs, Va.
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Shirras, A. L., Aberdeenshire, Scotland.
Shordon, N. C., Brilliant, Ohio.
Short, Frank James, Aspinwall, Pa.
Shrader, John, Iowa City, Iowa.
Shupe, Emmet C., Kingston, Ohio.
Siebler, Matthew, Dayton, O.
Siegmund, Louis K., Turner, Ore.
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Sincerbox, Jno. H., Jr., Wasaic, N. Y.
Sinclair, F. L., Haverhill, Mass.
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Smith, David, Taranaki, New Zealand.
Smith, David A., North Adams, Mass.
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Smith, George, Jr., Somerville, Mass.
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Smith, Herbert, Auckland, N. Z.
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Smith, L. I., Buckmanville, Pa.
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Spallholz, Henry A., Salem, N. Y.
Sparo, Willis M., Washington, D. C.
Spears, E. A., Crowley, La.
Speedy, J. H., Auckland, N. Z.
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Spencer, Welden S., Washington, D. C.
Standley, Fred A., Lynn, Mass.
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Steinweg, Fred, Chicago, Ill.
Stellhorn, Lawrence. Monticello, Ind.
Stenbol, Carl, Sydney, Cape Breton, Can.
Stevens, Elbert A., Wilson, N. Y.
Stevenson, G. W., Friendswood, Texas.
Stevenson, James, North Billerica, Mass.
Stewart, R. G., Memphis, Tenn.
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Sturgill, Perry, Glen Roy, O.
Sturm, Geo. J., Flora, Ill.
Sullivan, Wm., F., Mesa, Arizona.
Sutton, Leon, Oklahoma City, Okla.
Swanson, August, Vasa, Minn.
Swanson, Ed., Fresno, Cal.
Swartwood, C. I., Kearney, Neb.
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Tonkin, John C., Linwood, Pa.
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Torrey, E. J., Winchester, Mass.
Torrey, Leon E., Los Angeles, Cal.
Travis, Geo., Battle Creek, Mich.
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Tricot, Chas., Leominster, Mass.
Tripp, F. A., Merrick, Mass.
Troeller, C. F., Larrabee, Iowa.
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Tullett, Thomas, Golden, Colo.
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Turner, Herbert M., Quincy, Ill.
Turner, Marshall, Wyandotte, Mich.
Tyler, H. Upton, Berkeley, Cal.
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Underwood, Gilbert, Fleming, Pa.
Updegraff, Wm. B., Cambridge, Mass.
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Vannerburg, C. A., Perkinsville, N. Y.
Van Nort, James L., Belleview, Mo.
Varcoe, Thomas, Burson, Cal.
Van't Hoff, Jan., Leiden, Holland.
Vick, Chas. J., Rugby, England.
Virgo, Jas. E., Alliance, Ohio.
Voltz, Geo., Chicago, Ill.
Waddell, Geo. A., Baltimore, Md.
Wade, Archie, Amherst, Ohio.
Wade, Jesse Harris, Ipswich, Mass.
Waggoner, A. W., Deer Lodge, Mont.
Wagner, Wm. B., Forestville, Mich.
Wakefield, Vernon L., Milan, O.
Waldo, Alexis F., Whitinsville, Mass.
Walker, A. S., New York, N. Y.
Walker, Fred, Neola, Ia.
Wallace, Geo. G., Columbus, Ga.
Wallace, Geo. H., Moorhead, Minn.
Wallace, John D., Chicago, Ill.
Wallace, W. A., Arispe, Iowa.
Wallgren, Peter L., Passaic, N. J.
Walsh, Jas., New York, N. Y.
Walther, Victor S., Saginaw, Mich.
Waltz, Elmer W., Scranton, Pa.
Wanamaker, A. H., Lancaster, N. Y.
Wanless, Robert A., Windsor, Ont.
Ward, C. Richard, So. Thomaston, Me.
Ward, P. L., Monmouth, Ore.
Ware, Robert, Melrose, Mass.
Waream, Chas. E., Philadelphia, Pa.
Warnken, August J. L., Bucklin, Kan.
Washburn, H. W., New London, Conn.
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Weatherhead, O. L., Goshen, Ind.
Webb, Albert, Bainbridge, N. Y.
Webb, Frank R., San Francisco, Cal.
Webb, Richard L., St. Louis, Mo.
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Webster, Joel F., Canton, Ohio.
Wellman, J. J., Quincy, Ill.
Wells, Philip, Minneapolis, Minn.
Weirich, Harry C., Washington, D. C.
Welton, H. W., Lakeport, N. H.
Wesle, Joseph, Camden, N. J.
West, Frank, Morrison, Ill.
Westgate, Chas. R., Riceville, Pa.
Whaley, G. A., Webb City, Mo.
Wheeler, Maurice M., New York, N. Y.
Whitcomb, Orlow L., Pueblo, Colo.
White, A. F., London N., England.
White, Dennis P., Newark, O.
White, E. L., Edon, Ohio.
White, Geo. R., Danbury, Conn.
White, Lewis J., Peabody, Kans.
Whiteman, Jas. T., Park House, Bowling, Scotland.
Whiting, Louis D., Milldale, Conn.
Whitney, A. F., Oneonta, N. Y.
Whitney, Roy C., Kansas City, Mo.
Whittemore, Jas. H., Cambridge, Mass.
Wicks, E. E., Marcellus, N. Y.
Wieand, Clemence J., Cementon, Pa.
Wieand, Chas. W., Guth's Station, Pa.
Wilcox, J. Eugene, Mystic, Conn.
Wilkins, M. D., Union City, Pa.
Wilkinson, Thos. J., Montreal, Can.
Williams, Benj. F., Connellsville, Pa.
Williams, George T., Glendale, Minn.
Williams, Richard P., Chicago, Ill.
Williams, Robt. E., Enosburg, Vt.
Williamson, Jesse E., Warren, Ind.
Wilson, Andrew John, Torrington, Conn.
Wilson, Earle F., Eau Claire, Wis.
Wilson, Geo. W., Paradise, N. S.
Wilson, Howard G., Chicago, Ill.
Wilson, J. F., Jetmore, Kansas.
Wilson, Richard S., Portsmouth, Va.
Wilson, Smith, Grayville, Ill.
Winehold, Wm., Wadena, Ind.
Wires, Pearl J., Byesville, Ohio.
Wirth, Clarence E., Teaticket, Mass.
Wolcott, Oliver E., Amherst, Mass.
Wolf, Joseph F., Philadelphia, Pa.
Wood, J. W., Jackson, Mo.
Wood, Lester J., LaFarge, Wis.
Wood, Robert M., Winooski, Vt.
Woolcock, Chas., E. Peoria, Ill.
Worden, L. E., Roslindale, Mass.
Workman, Henry M., Wheeling, W. Va.
Worley, H., Gretna, La.
Wortman, Carl, Hamden Junction, Ohio.
Wright, A. F., E. Bridgewater, Mass.
Wright, Walter B., Chicago, Ill.
Wyman, Geo. M., Millville, N. Y.
Yauger, Harry H., Vernon, N. Y.
Yearsley, John H., Menan, Idaho.
Yeaton, C. R., Somerville, Mass.
Yocom, Luke F., Loaz, Pa.
Youd, J. J., Bagby, Cal.
Young, Alman G., Germantown, Wis.
Young, Henry, San Francisco, Cal.
Young, Russell, Almonte, Ont.
Yurkee, Paul, Adams, Mass.
Zabriskie, Seaman, New York, N. Y.
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